Prepared for:
U.S. Environmental Protection Agency
Region 7
901 North 5th Street
Kansas City, Kansas 66101

Operable Unit 1 Focused Feasibility Study Report

Residential Area Lead Contaminated Soils

Washington County Lead District – Richwoods Site
Washington County, Missouri

July 2010

EPA Contract No.: EP-S7-05-06
EPA Task Order No.: 0097
BVSPC Project No.: 044755

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ENERGY WATER INFORMATION GOVERNMENT

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Professional
Environmental Engineers, Inc.

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List of Acronyms

AES	Architect and Engineering Services
ARARs	Applicable or Relevant and Appropriate Requirements
BERA	Baseline Ecological Risk Assessment
BHHRA	Baseline Human Health Risk Assessment
BVSPC	Black and Veatch Special Projects Corp.
CALM	Cleanup Levels for Missouri
CAMU	Corrective Action Management Unit
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CERCLIS	Comprehensive Environmental Response, Compensation, and Liability Information System
C.F.R.	Code of Federal Regulations
COC	Contaminant of Concern
COPC	Contaminant of Potential Concern
CSR	Code of State Regulations
CTE	Central Tendency Exposure
EPA	US Environmental Protection Agency
FS	Feasibility Study
ft^2	square feet
GC	Government Control
HEPA	High Efficiency Particulate Air
HI	Hazard Index
HQ	Hazard Quotient
HRS	Hazard Ranking System
IC	Institutional Control
IEUBK	Integrated Exposure Uptake Biokinetic Model
LSFR	Little St. Francis River
MCL	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goal
MDNR	Missouri Department of Natural Resources
mg/cm^2	milligram per square centimeter
mg/kg	milligram per kilogram
mg/L	milligram per liter
NCP	National Oil & Hazardous Substances Contingency Plan
NPDES	National Pollutant Discharge Elimination system
NPL	National Priority List
OMB	Office of Management and Budget
OSWER	Office of Solid Waste and Emergency Response
OU	Operable Unit
O&M	Operation and Maintenance
PA	Preliminary Assessment
PbB	Blood Lead Level
PRG	Preliminary Remediation Goal
ppm	parts per million

RAO	Remedial Action Objectives
RAP	Remedial Action Plan
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
RME	Reasonable Maximum Exposure
ROD	Record of Decision
RSE	Removal Site Evaluation
SI/RA	Site Inspection/Removal Assessment
SMCL	Secondary Maximum Contaminant Level
TAL	Target Analyte List
TBC	To Be Considered
TCLP	Toxic Characteristic Leachate Procedure
TMDL	Total Maximum Daily Load
ug/dL	micrograms per deciliter
UIC	Underground Injection Control
U.S.C.	United States Code
WCHD	Washington County Health Department
XRF	X-Ray Fluorescence
yd^3	cubic yards

Executive Summary

This Feasibility Study (FS) is for residential soils remediation at the Washington County Lead District - Richwoods Site (Site) in Washington County, Missouri which is located in the central/southeastern portion of the state of Missouri. The FS has been prepared by Black & Veatch Special Projects Corp. (BVSPC) under the authority of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA). This FS has been prepared to assist in the selection of a remedial action for cleanup of contaminated residential soils in the Site.

Site Location, History, and Contamination

The Washington County Lead District is located in Washington County, Missouri. There are three contiguous sites identified within the Washington County Lead District and the entire area is part of the Old Lead Belt in Missouri. The Potosi Site is the southernmost of the three Washington County Lead District sites, located in the southeastern portion of Washington County and includes the towns of Potosi, Mineral Point, Springtown, Cadet, Summit, Bates Creek Camp, Happy Hollow, and Shibboleth. The Richwoods site is the northernmost site and is in the town of Richwoods in the northeast corner of Washington County. The Old Mines site is located between Potosi and Richwoods along the eastern edge of the county and includes the towns of Old Mines, Cruise Mill, Fertile, Latty, Bliss and Cannon Mines.

Potosi, Richwoods and Old Mines each have a long history of mining activities in the past few hundred years. Potosi was established in the late 1700's and quickly prospered to a mining industry town. Records indicate that 1,426 mines have been identified in Washington County. Lead deposits declined toward the end of the American Civil War and lead mining was replaced by the surface mining of barium. Barite was used for rubber, paint, soap, and mechanical products. By 1980, Barite production began to decline in Washington County. Lead in soils has been detected above the EPA's action level of 1,200 milligrams per kilogram (mg/kg) or parts per million (ppm) as well as elevated levels of arsenic and barium.

Previous field investigations were conducted by the EPA and the Missouri Department of Natural Resources (MDNR) at the Potosi, Richwoods, and Old Mines sites from 2005 – 2007 to characterize the nature and extent of residential soil and groundwater contamination throughout Washington County. Those investigations are discussed in detail in the respective Preliminary Assessment/Site Investigation (PA/SI) and/or Removal Site Evaluation (RSE) reports for each site (MDNR 2006; Tetra Tech 2006).

BVSPC conducted a field investigation in 2008 to collect data for the generation of a Baseline Human Health Risk Assessment (BHHRA) to assess the potential risks to humans from site-related contaminants present in environmental media. Residential soil samples, indoor dust, paint, and tap water samples were collected (BVSPC 2010a). The EPA Region 7 Environmental Services Division conducted a Baseline Ecological Risk Assessment (BERA) in 2008 (EPA 2008). This assessment collected samples of soils, vegetation, surface water, sediments, fish, and crayfish. Data collected from the BHHRA and BERA sampling was input into the Integrated Exposure Uptake Biokinetic Model (IEUBK) to predict risks from lead to children and adults. All previous investigation details and results were evaluated and placed in a Remedial Investigation (RI) report by BVSPC for Washington County (BVSPC 2010b).

Remedial Action Objectives and Action Levels

Conclusions from the BHHRA indicated that lead was a significant contaminant of concern that posed the primary threat to human health through direct ingestion exposure.

The following Remedial Action Objectives (RAO) have been developed for residential soils in Washington County:

- Reduce the risk of exposure of young children to lead in soil such that an individual child, or group of similarly exposed children, have no greater than a five percent chance of having a blood-lead concentration exceeding 10 micrograms per deciliter (ug/dL).
- Reduce the risk of exposure of young children to concentrations of lead above 400 mg/kg in residential soils.
- Reduce the risk of exposure of young children to concentrations of arsenic above 22 mg/kg in residential soils.
- Reduce the risk of exposure of young children to concentrations of barium above 15,000 mg/kg in residential soils.
- Reduce the risk of exposure of young children to concentrations of cadmium above 70 mg/kg in residential soils.

A relative bioavailability value of 53.9 percent was determined for lead-contaminated, residential soils using in-vitro testing methods. The value was used in the IEUBK Model to predict that young children (less than seven years old) residing at the Site will have no greater than a five percent probability of having a blood-lead concentration of 10 μg/dL or greater at a soil concentration of 400 ppm or less. This 400 ppm Preliminary Remediation Goal (PRG) is based upon sieving the soil sample with a 60 mesh sieve and analysis of the sample by an X-Ray Fluorescence (XRF) instrument. Final cleanup levels for lead in residential soil at Superfund sites generally are based on the IEUBK model results and the nine criteria analysis per the National Oil & Hazardous Substances Contingency Plan (NCP). Residential properties with lead levels above 400 ppm will be considered for remediation during the EPA remedial action for residential soils.

The EPA has initiated Time-Critical Removal Actions at properties with soil lead contamination levels above 1,200 mg/kg. These residences have been remediated by excavation, backfill, and addition of vegetative cover. There remain approximately 98 residential yards with lead levels exceeding the PRG established for the Site of 400 ppm. This FS will focus on the remediation alternatives for these remaining properties.

Remedial Alternatives

Response Options for addressing the soil lead contamination at the Site are commonly referred to as remedial alternatives. The remedial alternatives' technologies address the soil contamination at the Site. The goal in developing the preliminary remedial alternatives is to provide both a range of cleanup options and sufficient detail to adequately compare the alternatives. The three remedial alternatives evaluated in this FS include the following:

- Alternative 1: No Action
- Alternative 2: 12-Inch Soil Excavation, Disposal, Vegetative Cover, Health Education, and Institutional Controls
- Alternative 3: 24-Inch Soil Excavation, Disposal, Vegetative Cover, Health Education, and Institutional Controls

Alternative 1: No Action

The EPA is required by the NCP, 40 C.F.R. § 300.430(e)(6) to evaluate the no action alternative. The No Action Alternative may be appropriate at some sites where a removal action has already occurred that reduced risks to human health and the environment. But the concentrations of metals in soils at many residential properties remain at levels that present a risk to human health, (e.g., lead concentrations greater than 400 ppm) particularly for young children residing at the Site.

Alternative 2: 12-Inch Soil Excavation, Disposal, Vegetative Cover, and Health Education and Institutional Controls

Under this alternative, soils from approximately 98 residential properties contain or are expected to contain soil lead concentrations greater than 400 ppm and will be excavated and disposed. Residential properties would have the contaminated soil removed to a maximum depth of 12-inches or until the lead concentrations in the soil were below 400 ppm. If at 12 inches below ground surface (bgs) the soil lead concentration is equal to or greater than 1,200 mg/kg, EPA will place a marker barrier prior to backfilling with clean soil. This barrier will be permeable, wide-meshed, and will not affect root growth, soil hydrology, or vegetation. This barrier is to act as a warning device that digging deeper may result in exposure to soil lead concentrations that exceed health-based levels determined for the Site and the potential to bring lead-contaminated soil to the surface after the soil disturbance activities are completed. EPA will work with state and local officials and land owners to explore potential institutional controls for properties where soil lead contamination remains at depth, i.e. where marker barrier was placed; and on those properties where EPA has data indicating surface soil lead contamination exceeds 400 mg/kg and EPA was unable to get access from the property owner to perform the soil replacement.

Excavated soil would be disposed at the existing Indian Creek Repository. The Indian Creek Repository will be constructed to minimize risks to human health and the environment, including reduction of contaminant migration to groundwater and surface water. Groundwater and surface water will also be further protected by treating soils that fail the Toxic Characteristic Leachate Procedure (TCLP) with a lead stabilization agent before final placement in the repository. Unacceptable impacts associated with implementation of this alternative are not anticipated.

This alternative would control the significant exposure pathways associated with lead-contaminated residential soils. The completion of replacement of the upper 12 inches of lead-contaminated soil, followed by the establishment of vegetation in yards, and the implementation of a health education program and institutional controls will sufficiently mitigate the risks associated with lead-contaminated, residential soils. Therefore, Alternative No. 2 is protective of human health and the environment.

<u>Alternative 3: 24-Inch Soil Excavation, Disposal, Vegetative Cover, Health Education, and Institutional Controls</u>

Under this alternative, soils from approximately 98 residential properties contain soil lead concentrations greater than 400 ppm and require excavation and backfill. Residential properties would have the contaminated soil removed to a maximum depth of 24-inches or until the lead concentrations in the soil were below 400 ppm. If at 24 inches bgs the soil lead concentration is equal to or greater than 1,200 mg/kg, EPA would place a marker barrier prior to backfilling with clean soil and would implement institutional controls, as in Alternative 2, after consulting with ATSDR for concurrence on the need for institutional controls for soil lead contamination remaining at the 24-inch depth. However, the EPA anticipates that the need for institutional controls would be reduced because homeowners would dig in their yards to depths exceeding 24 inches on rare occasions, and believes that those instances would not result in soil lead levels remaining at the surface that would pose a significant exposure risk to lead. The frequency of post remediation excavation by residents to depths greater than 24 inches is expected to be minimal over time, and the perpetual implementation of institutional controls may be necessary on fewer properties in order for human health and the environment to be protected.

Excavated soil would be disposed at the existing Indian Creek Repository. The Indian Creek Repository will be constructed to minimize risks to human health and the environment, including reduction of contaminant migration to groundwater and surface water. Groundwater and surface water will also be further protected by treating soils that fail the Toxic Characteristic Leachate Procedure (TCLP) with a lead stabilization agent before final placement in the repository. Unacceptable impacts associated with implementation of this alternative are not anticipated.

This alternative would control the significant exposure pathways associated with lead-contaminated residential soils. The completion of replacement of up to the upper 24 inches of lead-contaminated soil, followed by the establishment of vegetation in yards, and the implementation of a health education program and institutional controls will sufficiently mitigate the risks associated with lead-contaminated, residential soils. Therefore, Alternative No. 3 is protective of human health and the environment.

Analysis of Remedial Alternatives

A detailed evaluation of the remedial alternatives was performed using seven of the nine EPA evaluation criteria and is summarized in Table ES-1.

- Protection of Human Health and the Environment
- Compliance with ARARs
- Long-Term Effectiveness and Performance
- Reduction of Toxicity, Mobility, or Volume
- Short-Term Effectiveness
- Implementability
- Cost

State and community acceptance criteria cannot be adequately addressed until after the FS Report is released for regulatory and public review. These criteria will be assessed in the Record of Decision (ROD) Responsiveness Summary.

Table ES-1
Comparative Analysis of Alternatives
Washington County Lead District - Richwoods Site

Evaluation Criteria	Alternative 1 No Action	Alternative 2 12-Inch Soil Excavation	Alternative 3 24-Inch Soil Excavation
Overall Protection	This alternative would not provide protection of human health or the environment. No remedial action objectives would be satisfied.	This alternative is protective of human health and the environment.	This alternative is protective of human health and the environment.
Compliance with Applicable or Relevant and Appropriate Requirements (ARARs)	This alternative does not meet the potential ARARs for the state or federal chemical- specific, location specific, or action specific ARARs	This alternative would comply with the chemical-specific, location- specific and action specific ARARs	This alternative would comply with the chemical-specific, location- specific and action specific ARARs
Long-Term Effectiveness	This alternative does not provide active reduction in long-term risks. No long-term controls would be implemented.	The residual risks would be reduced for residential properties within the site with soil concentrations above 400 ppm lead through excavation and removal of contaminated soils, and the implementation of health education programs.	The residual risks would be reduced for residential properties within the site with soil concentrations above 400 ppm lead through excavation and removal of contaminated soil and the implementation of health education programs.
Reduction of Toxicity, Mobility, and Volume	Unknown if reduction of contamination would be achieved. There would be no mechanisms to monitor contamination levels.	This alternative would significantly reduce the mobility of the contaminants of concern by consolidation of the contaminated soils in the Indian Creek Repository.	This alternative would significantly reduce the mobility of the contaminants of concern by consolidation of the contaminated soils in the Indian Creek Repository.
Short-Term Effectiveness	Because no actions would be conducted, there would be no increase in the short-term risk to the workers, the community, or the environment.	This alternative is protective in the short term. Although lead-laden dust could be generated during excavation, dust suppression would be implemented for the protection of community and workers during the remedial action.	This alternative is protective in the short term. There would be the potential for longer-term exposure to lead-laden dust generated during excavation due to additional excavation.

Table ES-1, Continued
Comparative Analysis of Alternatives
Washington County Lead District - Richwoods Site

Evaluation Criteria	Alternative 1 No Action	Alternative 2 12-Inch Soil Excavation	Alternative 3 24-Inch Soil Excavation
Implementability	The implementability criterion is not applicable because no remedial activities would occur.	The excavation portion of this alternative is fully implementable. Excavation methods, backfilling, and revegetation are typical engineering controls. However, the IC portion of this alternative has not been tested in Region 7.	This alternative is fully implementable. Excavation methods, backfilling, and revegetation are typical engineering controls. Health education is being implemented at other sites in Region 7, but the IC portion of this alternative has not been tested in Region 7.
Cost (Total Present Worth)	$ 0	$ 2,874,749	$ 4,095,050

1.0 Introduction

This Feasibility Study (FS) for residential soils remediation at the Richwoods Site, Richwoods, Missouri has been prepared under the authority of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA). The purpose of this FS is to assist in the selection of a remedial action for cleanup of contaminated residential soils at the Site. This FS has been prepared by Black & Veatch Special Projects Corp. (BVSPC) for the U.S. Environmental Protection Agency (EPA) under the Region 7 Architect & Engineering Services (AES) Contract, Task Order 0097.

1.1 Purpose and Organization of the Report

The FS process is the procedure used to develop, evaluate, and select a remedial action. The FS report provides documentation for this process. This FS report focuses specifically on residential, lead-contaminated soils [Focused Operable Unit One (OU1)] of the Site. The goals of this FS include the following:

- Providing a framework for evaluating and selecting technologies and remedial actions.
- Satisfying environmental review requirements for a Superfund remedial action (RA).
- Complying with administrative record requirements for documentation of Superfund remedial action selection.

The purpose of the FS report is to present and evaluate the remedial alternatives that may be used to address the risks posed by the Site. This FS, the Remedial Investigation (RI), and the Baseline Risk Assessment form the basis from which a Proposed Plan will be developed. This FS does not propose a preferred remedial action. In the Proposed Plan, the EPA will indicate which remedial alternative it prefers and seek public input on the recommended alternative. Once the public has had an opportunity to review and comment on the Proposed Plan, a Record of Decision (ROD) will be issued by the EPA selecting a remedial action.

In addition to this introduction, this report is organized into the following sections:

- Section 2 – Potential ARARs
- Section 3 – Remedial Action Objectives and Action Levels
- Section 4 – Identification and Screening of Applicable Technologies and Process Options
- Section 5 - Development of Alternatives

- Section 6 - Detailed Evaluation of Remedial Alternatives
- Section 7 - Comparative Analysis of Alternatives
- Section 8 - References

1.2 Background Information

1.2.1 Site Location and Description

The Washington County Lead District is located in Washington County, Missouri. There are three contiguous sites identified within the Washington County Lead District and the entire area is part of the Old Lead Belt in Missouri. The Potosi Site is the southernmost of the three Washington County Lead District sites, located in the southeastern portion of Washington County and includes the towns of Potosi, Mineral Point, Springtown, Cadet, Summit, Bates Creek Camp, Happy Hollow, and Shibboleth. The Richwoods site is the northernmost site and includes the town of Richwoods in the northeast corner of Washington County. The Old Mines site is located between Potosi and Richwoods along the eastern edge of the county and includes the towns of Old Mines, Cruise Mill, Fertile, Latty, Bliss and Cannon Mines. See Figure 1-1 for site locations.

The Potosi, Richwoods and Old Mines sites each have a long history of mining activities spanning the past three hundred years. Records indicate 1,426 mines have been identified in Washington County. Lead in soils has been detected above the EPA's time-critical removal action level of 1,200 milligrams per kilogram (mg/kg) or parts per million (ppm). To a lesser degree, arsenic and barium has been detected in residential soils at concentrations exceeding health based levels.

This FS will focus on residential soil contamination at the Richwoods site defined as Operable Unit 1 (OU1). Groundwater contamination and mine waste source areas will be addressed in future remedial actions. The area to be discussed in the OU1 FS is shown on Figure 1-2.

1.2.2 Operational History and Waste Characteristics

Written records of mining activities for lead in Washington County were first recorded as early as 1700. Continuous lead mining started in 1721 and soon mining activities increased to the production rate of 1,500 pounds of ore per day. These early mining efforts were accomplished by digging small pits and shafts less than 10 feet deep by hand labor. Area farmers operated small mines to supplement their income during winter months. One hundred years after the mining began Moses Austin moved into the region and started deeper mining along with the use of a reverberatory furnace to smelt the lead ore which tripled the yield of lead.

Barite was discarded by early miners because uses for the material were yet to be discovered, but was found to be a long-lasting white pigment after the Civil War. Lead and barite mining continued to be performed by hand until 1924 when the processes became mechanized. Barite was soon found to be a useful weighting agent in oil drilling mud and made Washington County the world leader in barite production until around 1985 when competition from other sources decreased demand (MDNR 2006).

1.2.3 Nature and Extent of Contamination

Although mining-related contamination has affected a number of media (soil, surface water, sediment, etc.) and sources remain at the Site (tailings impoundments, chat, etc.), this FS is focused only on residential property soils at the Site. Consequently, only the nature and extent of contamination as it relates to residential property soil will be discussed in this section of the FS. Residential properties are defined in EPA's *Superfund Lead-Contaminated Residential Sites Handbook* as properties that contain single and multi-family dwellings, apartment complexes, vacant lots in residential areas, schools, day-care centers, playgrounds, parks, and green ways (EPA 2003).

Between 2004 and 2006, the Missouri Department of Natural Resources (MDNR) and EPA completed an initial screening of public lands evaluation, a Pre-Comprehensive Environmental Response and Liability Information System (Pre-CERCLIS) screening assessment, abbreviated Preliminary Assessment (PA), and combined Site Inspection/Removal Assessment (SI/RA) at the Site. The EPA, through its contractors, collected soil samples, potable water samples, and dust samples from residential properties during the Remedial Investigation (RI). The Hazard Ranking System (HRS) Documentation Record package was completed for the Site by Tetra Tech EM, Inc., in September 2007 and the Site was proposed for addition to the National Priorities List (NPL). The Site was added to the NPL on March 19, 2008.

From late 2005 through February 2006, EPA conducted a Removal Site Evaluation (RSE) at the Site. Soil and groundwater samples were collected to further define the extent of metals contamination in surface soils and drinking water at the Site (Tetra Tech 2006). The soil sampling results are shown in Figure 1-3.

Residential soil samples were collected at 48 properties during the 2008 RI. A total of 307 soil samples were analyzed in the field by x-ray fluorescence (XRF) and 27 samples were submitted for laboratory confirmation for the 48 properties. (BVSPC 2010b)

During the 2008 RI, interior dust samples were collected from 43 homes in Washington County where soil samples had previously been collected. The purpose of the dust sampling was to collect data that could be used to prepare the Human Health Risk Assessment. Three dust samples were collected in each residence and analyzed for lead and other Target Analyte List (TAL) metals. There are no EPA criteria for defining acceptable lead concentrations in the dust. Lead was detected in indoor dust from vacuum samples at all properties sampled within the Site.

Concentrations of lead in dust from the home interior vacuum samples ranged from 13.2 to 581 mg/kg (BVSPC 2010b)

Also, during the 2008 RI, field screening for lead-based paint was conducted in homes which were built prior to 1980 or were not pre-manufactured housing (i.e. mobile homes constructed with metal components). A Niton XRF analysis was performed on selected painted surfaces and lead concentrations were obtained from painted walls, ceilings, columns, windows, and cabinets which consisted of wood, drywall, plaster, and concrete located in various interior and exterior living spaces. Lead in paint was detected at five properties and ranged from 1.66 to 5.25 milligrams per square centimeters (mg/cm^2).

At this time residential yards with lead levels above 1,200 mg/kg have been remediated by excavation, backfill, and vegetative cover. The lead soil concentration of 400 ppm is significant because the 1994 Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities (OSWER Directive 9355.4-12) recommends a 400 ppm screening level for lead in soil at residential properties. An estimated 98 residential properties at the Site remain contaminated with soil lead concentrations greater than 400 ppm. The lead concentrations from the residential property soil sampling performed by Tetra Tech and BVSPC are presented in the Remedial Investigation (RI) report (BVSPC 2010b).

An estimate of the number of residences requiring remediation at the Site was calculated based upon the combined results of the RSE and 2008 RI data. The residences that may require remediation are based on cleanup levels of 400 ppm and 1,200 ppm lead in soil. The soil lead concentration of 400 ppm is significant because the 1994 Revised Interim Soil Lead for CERCLA Sites and RCRA Corrective Action Facilities (OSWER Directive 9355.4-12) recommends a 400 ppm screening level for lead in soil at residential properties (EPA 1994). The lead concentration of 1,200 ppm is significant because that is the level used by EPA at the Site to determine if a time-critical removal action at a residential property is warranted. Previous sampling has identified 61 properties with soil lead concentrations greater than 400 ppm. It is estimated that of the 176 residential properties within the Site area that have yet to be sampled, 20 percent will have lead concentrations in the soil greater than 400 ppm and 1 percent will have lead concentrations in the soil greater than 1,200 ppm. Therefore, the total estimated number of residences requiring remediation at the Site is as follows:

- 96 residences with lead concentrations in the soil between 400 and 1,200 ppm
- 2 residences with lead concentrations in the soil greater than 1,200 ppm

The estimates listed above do not include the 19 residential yards with lead levels greater than 1,200 ppm that were previously remediated as a time-critical removal action.

1.2.4 Contaminant Fate and Transport

The primary sources of contamination at the Washington County Lead District sites is the mining wastes associated with the historical lead mining and smelting that was prevalent from the early 1700's to the early 1900s, and the mine waste deposits generated from barite mining during the 1900s. The source areas associated with some of the more recent barite mining are uncapped piles with often sparse vegetative cover, tailings ponds, mined pits, and tiff cuts. The source materials primarily consist of the following two types of material depending on the mining process used:

Tailings - sand and silt sized particles produced by froth flotation which were slurried to diked impoundments and deposited across stream valleys.

Chat – sand and gravel sized particles produced by a dry process called gravity separation.

The source areas associated with historical lead mining at the sites are suspected to be widespread based on limited records and the nature of the surface mining and smelting of lead ores during the 1800s. The lead deposits were typically located at or near the ground surface. Lead mining spoils or diggings were left on the ground surface. Early smelters, referred to as log and kiln furnaces, were inefficient and generated highly, lead-contaminated wastes that were also discarded on the ground surface.

Based on the nature of the contamination and the physical characteristics of the Site, potential routes of contaminant migration likely include the following:

- Mechanical distribution of mine waste
- Soil/mine waste to air migration
- Soil/mine waste to surface water/sediment migration
- Soil/mine waste to groundwater migration
- Groundwater to surface water migration
- Biological/food chain migration

Mechanisms capable of transporting contaminants from these sources include the following, although not all of the transport mechanisms are significant at all of the sites:

- Wind dispersal of fine mine waste material,
- Water erosion and transport of mine waste and contaminated soil,
- Mass movement of mine waste through slope failure and debris flow,
- Surface water runoff to streams, and
- Subsurface flow of groundwater.

1.2.5 Baseline Human Health Risk Assessment

A Baseline Human Heath Risk Assessment (BHHRA) was conducted for the Site to assess the potential risks to humans, both now and in the future, from site-related contaminants present in environmental media (BVSPC 2010a). The BHHRA assumes that no steps are taken to remediate the environment or to reduce human contact with contaminated environmental media. The conclusions of the BHHRA are intended to help inform risk managers and the public about potential human risks attributable to site-related contaminants and to help determine if there is a need for action at the Site.

There are four steps in the BHHRA process: data collection and evaluation; exposure assessment; toxicity assessment; and risk characterization. Each of these steps is summarized below, along with how they were conducted for the Site.

Step 1: Data collection and evaluation involves gathering and analyzing the site data relevant to the human health evaluation, as well as identifying the contaminants present at the Site that are the focus of the BHHRA process.

Samples were collected to determine the magnitude and extent of metals contamination in residential properties, indoor house dust, driveways, drinking water wells, streams, ponds, sediments, mine waste piles, and fish tissues. Based on the environmental sampling results, the BHHRA identified the following metals as chemicals of potential concern (COPCs) in one or more environmental media: aluminum, antimony, arsenic, barium, cadmium, cobalt, iron, lead, manganese, vanadium, and zinc. COPCs are chemicals which exist in the environment at concentration levels that might be of potential health concern to humans and which are or might be derived, at least in part, from site-related sources. While numerous metals were identified as COPCs, lead is the contaminant of primary health concern at the Site. All COPCs were quantitatively evaluated to determine their potential impacts on human health.

Step 2: Exposure assessment is conducted to estimate the magnitude of actual and/or potential human exposures, the frequency and duration of these exposures, and the pathways by which humans are potentially exposed.

The BHHRA focused on the human populations most likely to be exposed to site-related chemicals which included child and adult residents. However, exposure of residents from ingestion of garden vegetables was not quantitatively evaluated because environmental data was not available.

There is normally a wide range of exposure to site-related contaminants between different members of an exposed population. Thus, the BHHRA estimated the magnitude of exposures or intakes that are "average" or are otherwise near the central portion of the range, and the intakes that are near the upper end of the range (e.g., the 95th percentile). These two exposure estimates are referred to as Central Tendency Exposure (CTE) and Reasonable Maximum Exposure

(RME) estimates, respectively. The RME represents the highest exposure that is reasonably expected to occur at a site, but that is still within the range of possible exposures.

For each receptor (i.e., child resident, etc.), the exposure assessment estimated the intake of contaminants specific to an area within which a receptor is likely to spend most of their time, which is called the exposure unit or exposure area. For example, individual residential properties were selected as the exposure unit for child and adult residents because most exposure will occur within the boundaries of the residential property where the individual lives.

Step 3: Toxicity assessment identifies the types of adverse health effects associated with exposure to a contaminant and how the appearance of these adverse health effects is related to the exposure level. BHHRAs typically characterize potential non-cancer and cancer health effects separately. They are evaluated separately because for non-cancer health effects it is assumed there is a level or "threshold" which will not result in adverse health effects, while for cancer effects it is typically assumed that exposure to any level will increase the risk or probability of developing cancer (i.e., no threshold exists).

Step 4: Risk characterization integrates the exposure and toxicity assessments to quantify the risks or potential for adverse non-cancer and cancer health effects. This final step also discusses the uncertainties of each step of the BHHRA and their impact on the risk estimates.

For most chemicals, the potential for non-cancer effects is evaluated by comparing the estimated daily intake of the contaminant over a specific time period with a level not associated with adverse health effects for that contaminant. This comparison results in a non-cancer Hazard Quotient (HQ), while a Hazard Index (HI) is calculated when an individual is exposed to more than one chemical or exposure pathway, such as eating and breathing a contaminant. If the HQ or HI for a contaminant(s) is equal to or less than one, it is believed that there is no appreciable risk that non-cancer health effects will occur, including sensitive subpopulations. If an HQ exceeds one, there is a possibility that non-cancer effects may occur and a level of concern has been exceeded, although the probability of adverse health effects is unknown.

For contaminants that EPA considers potentially carcinogenic in humans, the BHHRA estimates the risk or probability that an individual will develop cancer over a lifetime as a result of exposure to site-related contaminants. For example, the cancer risk is expressed as a probability of 1 in 10,000 in an individual or for every 10,000 people exposed to the contaminant, one extra or excess cancer case may occur beyond what would normally be expected from all other causes of cancer. The cancer risks are summed across all chemicals of concern and all exposure pathways that contribute to exposure of an individual in a given population. In general, EPA considers excess cancer risks that are below 1 in 1,000,000 or 1E-06 to be so small as to be negligible, and risks above 1 in 10,000 or 1E-04 to be sufficiently large that some sort of remediation is desirable. Excess cancer risks that range between 1 in 10,000 and 1 in 1,000,000 are generally considered to be acceptable, although this is evaluated on a case by case basis.

The risks or potential for adverse human health effects for lead are evaluated using a different approach than for most other metals. Because lead is widespread in the environment, exposure can occur by many different pathways. Thus, lead risks are based on consideration of total exposure (all pathways) rather than just site-related exposure. In addition, because most studies of lead exposures and resultant health effects in humans have traditionally been described in terms of blood lead level (PbB), expressed in units of micrograms per deciliter or µg/dL), lead exposures and risks are typically assessed using mathematical models.

The BHHRA for the Site used EPA's Integrated Exposure Uptake Biokinetic (IEUBK) Model for Lead in Children and the Adult Lead Methodology to estimate the distribution of blood lead levels in a population of children and adults, respectively, exposed to lead at the Site. EPA has established a health protection goal that there be no more than a 5% chance that an exposed individual (a child less than 7 years of age or a woman of child-bearing age) will have a blood lead level that exceeds 10 µg/dL. For convenience, this probability is referred to as P10.

1.2.5.1 Risk Estimates for Residents

Risks from Soil

Lead was identified as a Contaminant of Concern (COC) for current and future residential exposures to WCLD area-wide soils and groundwater. Of the 950 samples of WCLD area-wide soil that were evaluated, 531 (56%) are predicted to have P10 values at or below 5%, and 419 samples (44%) are predicted to have P10 values that exceed the goal.

Risks from Groundwater

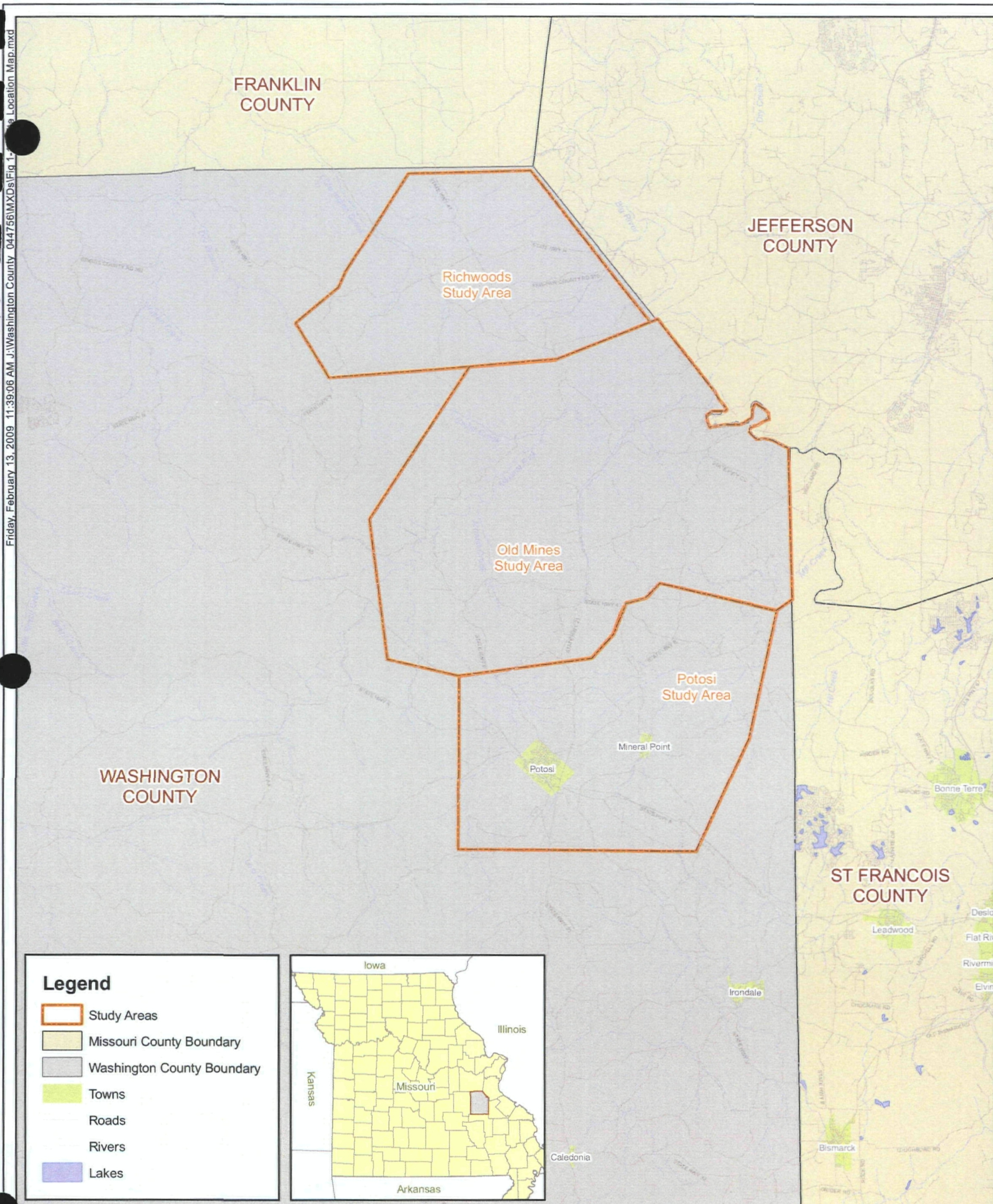
Risks from ingestion of groundwater were determined for (1) current residents from the ingestion of groundwater in residential wells at and near WCLD and (2) future residents from the ingestion of groundwater if the shallow groundwater from the mine areas were used in the future for drinking water.

Both CTE and RME non-cancer risks to current residents (children and adults) from the ingestion of groundwater are below a level of concern at many wells, although some exceedances occur for CTE and/or RME receptors at some wells.

If the shallow groundwater at the mine areas were used for drinking by future residents, non-cancer risks would be above a level of concern to both child and adult residents at most wells in the vicinity of the Site. This non-cancer risk is attributable to a variety of different metals, including arsenic, cobalt, manganese, and nickel, with additional contributions from iron and zinc at some wells. In most cases, concentrations of metals, and thus estimated risks, are higher in the total fraction than the dissolved fraction.

Excess cancer risks from the concentration of metals in the dissolved fraction are above EPA's usual level of concern (1E-04) at several locations, with estimated risks in the range of 2E-05 to 6E-04 at a number of wells. In all cases, this risk is attributable to the presence of arsenic. Excess cancer risks from the concentration of metals in the total fraction could not be determined, because all results were non-detect and the detection limits were too high to be useful in calculating risk estimates. If concentrations in the total fraction are similar or higher than those observed in the dissolved fraction, then excess cancer risks may also be above EPA's usual level of concern at several locations from concentrations of arsenic in the total fraction (unfiltered groundwater).

These results indicate that the concentrations of several metals in both filtered and unfiltered fractions of shallow groundwater at mine waste areas would pose unacceptable non-cancer and cancer risks if it were used as drinking water by future residents.



Site Location Map
Washington County Lead District
Washington County, MO

Figure 1-1

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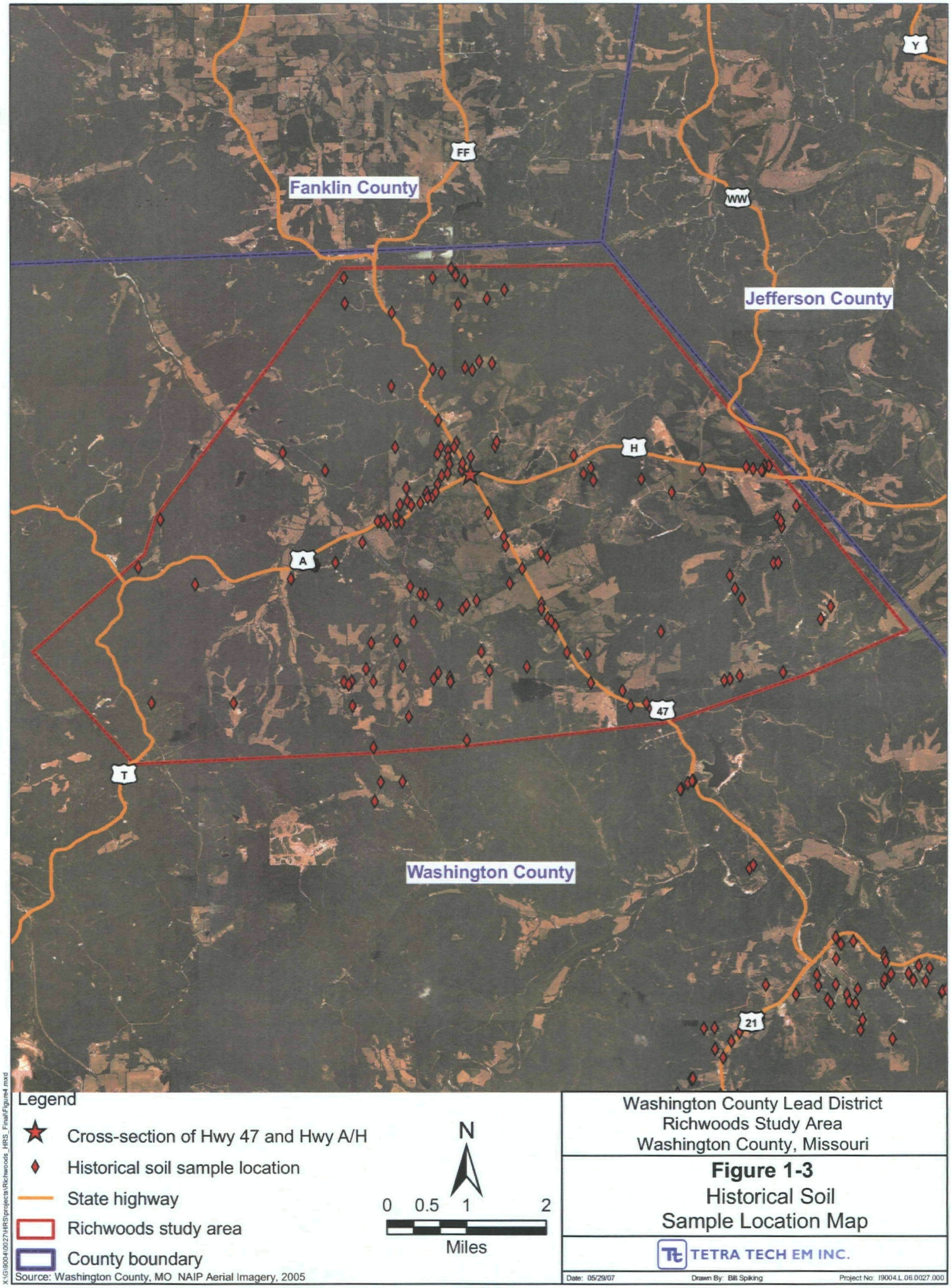
Figure 1-2
Richwoods Site Study Area Map
Washington County Lead District
Washington County, MO

NAD 1983, UTM, 15N



Washington County Lead District
Richwoods Study Area
Washington County, Missouri

Figure 1-3
Historical Soil
Sample Location Map

TETRA TECH EM INC.

Date: 05/29/07 Drawn By: Bill Spiking Project No: I9004.L.06.0027.000

2.0 Potential ARARs

Pursuant to Section 121(d) of CERCLA, 42 United States Code (U.S.C.) § 9621(d), remedial actions shall attain a degree of cleanup of hazardous substances, pollutants, and contaminants released into the environment and control of further release which, at a minimum, assures protection of human health and the environment. In addition, remedial actions shall, upon their completion, reach a level or standard of control for such hazardous substances, pollutants, or contaminants which at least attains legally applicable or relevant and appropriate federal standards, requirements, criteria, or limitations, or any promulgated standards, requirements, criteria, or limitations under a state environmental or facility siting law that is more stringent than any federal standard. These are termed as applicable or relevant and appropriate requirements (ARARs). In instances where the remedial actions do not achieve ARARs, the EPA must provide the basis for a waiver. An ARARs waiver is not contemplated for any of the alternatives evaluated in this FS.

Applicable requirements are those standards, requirements, criteria, or limitations promulgated under federal, state, or local law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site. Relevant and appropriate requirements are those standards, requirements, criteria, or limitations promulgated under federal, state, or local law that address problems or situations similar to those encountered at the CERCLA site; and therefore, are well suited for that site. Although not legally applicable, these requirements may nonetheless be relevant and appropriate for a particular CERCLA site.

EPA Region 7 and the State of Missouri determine which requirements are ARARs by considering the type of remedial actions contemplated, the hazardous substances present, the waste characteristics, the physical characteristics of the site, and other appropriate factors. Only the substantive portions of the requirements need to be followed for on-site actions; CERCLA procedural and administrative requirements require safeguards similar to those provided under other laws. Under Section 121(e) of CERCLA, 42 U.S.C. § 9621(e), and the National Oil and Hazardous Substances Contingency Plan (NCP), 40 Code of Federal Regulations (C.F.R.) § 300.400(e), federal, state, and local permits are not required for the portions of CERCLA cleanups that are conducted entirely onsite, as long as the actions are selected and carried out in compliance with Section 121 of CERCLA.

There are three types of ARARs. The first type includes chemical-specific requirements. These ARARs set limits on concentrations of specific hazardous substances, pollutants, and contaminants in the environment. Examples of these types of ARARs are drinking water standards and ambient water quality criteria. Frequently, the chemical-specific ARARs constitute a basic level of protectiveness for certain hazardous substances. However, for some media, chemical-specific ARARs are not available.

A second type of ARAR includes location-specific requirements that set restrictions on certain types of activities such as those in wetlands, floodplains, and historic sites. Location specific ARARs generally apply to most alternatives under consideration because they are based on the location of the site.

The third type of ARAR includes action-specific requirements. These are technology-based restrictions that are triggered by the type of remedial action under consideration. Examples of action-specific ARARs are Resource Conservation and Recovery Act (RCRA) regulations for waste treatment, storage and disposal. Action-specific ARARs may vary depending on the remedial alternative under consideration. Potential federal and state action-specific ARARs are identified in Section 5 as each alternative is subjected to detailed analysis.

The potential federal and state chemical, location, and action-specific ARARs for OU1 of the Site, identified by the EPA, respectively, are presented in Tables 2-1 through 2-6. These tables cite the requirements identified, state whether the requirements are applicable or relevant and appropriate, or to be considered and summarize the substantive standards to be met. To be considered (TBC) criteria consist of advisories, criteria, or guidance that were developed by the EPA, other federal agencies, or states that may be useful in developing CERCLA remedies. TBCs do not meet the definition of ARAR, but may be necessary to determine what is protective, and are useful when ARARs are not available.

2.1 Potential Chemical-Specific ARARs

The potential chemical-specific ARARs identified for this Site relate to protection of human health from exposure to residential property soils because of the unacceptable risks associated with exposure of humans, particularly children under 7 years old, to contaminated property soils. As discussed above, the principal contaminant is lead derived from mining related operations.

There are no Federal or State of Missouri promulgated standards, requirements, criteria or limitations to control the level of hazardous substances, pollutants, or contaminants in the soil at residential properties. Therefore, the alternatives evaluated for this FS do not have chemical-specific ARARs for contaminated soils in residential properties. However, the BHHRA and other federal and state guidance are available to evaluate each alternative for its ability to achieve a basic level of protectiveness for hazardous substances in soil. Tables 2-1 and 2-2 identify the potential federal and state chemical-specific ARARs for the Site.

2.2 Potential Location-Specific ARARs

Physical characteristics of the Site may influence the type and location of remedial responses considered for this FS. Potential federal and state location-specific ARARs, presented in Tables 2-3 and 2-4, relate to historic preservation, fish and wildlife coordination procedures, wetlands protection, flood plains protection, and work in navigable waters.

2.3 Potential Action-Specific ARARs

Action-specific requirements are not established for a specific contaminant, but rather by the activities that are selected to accomplish the remedy. Action-specific ARARs may establish performance levels, actions, or technologies as well as specific levels for discharged or residual contaminants. Tables 2-5 and 2-6 present the potential action-specific ARARs for the Site. The action-specific ARARs for each alternative will vary depending on the technologies employed. A discussion of when the ARAR would be applicable or relevant and appropriate is included in Tables 2-5 and 2-6.

2.4 Summary of ARARs

Contamination in the residential soils at the Site poses a potential threat to human health. CERCLA requires that any remedial action selected shall attain a degree of cleanup, which at a minimum assures protection of human health and the environment.

The BHHRA and the EPA and state guidance are to be used for the effective evaluations of the remedial alternatives herein. Based on present knowledge, protection of human health can be provided by attaining the levels of protectiveness described in the BHHRA.

Table 2-1
Potential Federal Chemical-Specific ARARs

	Citations	Description
A. Potential ARARs		
1. EPA Revised Interim Soil-lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities	Office of Solid Waste and Emergency Response (OSWER) Directive 9355.4-12, July 14, 1994	Establishes screening levels for lead in soil for residential land use, describes development of site-specific preliminary remediation goals, and describes a plan for soil-lead cleanup at CERCLA sites. This guidance recommends using the EPA Integrated Exposure Uptake Biokinetic Model (IEUBK) on a site-specific basis to assist in developing cleanup goals.
2. EPA Strategy for Reducing Lead Exposures	EPA, February 21, 1991	Presents a strategy to reduce lead exposure, particularly to young children. The strategy was developed to reduce lead exposure to the greatest extent possible. Goals of the strategy are to 1) significantly reduce the incidence above 10 μg Pb/dL in children; and 2) reduce the amount of lead introduced into the environment.
3. Residential Lead-Based Paint Hazard Reduction Act	Toxic Substances Control Act (TSCA) Disclosure Rule 1018, August 2009 40 C.F.R. Part 745, Subpart F	Requires disclosure of known lead-based paint hazards by persons selling or leasing housing constructed before 1978. Copies of all available records must be provided to the purchaser or lesee. Sellors or lessors must provide a copy of the EPA lead hazard information pamphlet: *Protect Your Family From Lead in Your Home (June 2003).*
B. To Be Considered		
3. Safe Drinking Water Act	National Primary Drinking Water Standards 40 C.F.R. Part 141 Subpart B and G	Establishes maximum contaminant levels (MCLs), which are health based standards for public waters systems.
4. Safe Drinking Water Act	National Secondary Drinking Water Standards 40 C.F.R. Part 143	Establishes secondary maximum contaminant levels (SMCLs) which are non-enforceable guidelines for public water systems to protect the aesthetic quality of the water. SMCLs may be relevant and appropriate if groundwater is used as a source of drinking water.
5. Safe Drinking Water Act	Maximum Contaminant Level Goals (MCLGs) 40 C.F.R. Part 141, Subpart F	Establishes non-enforceable drinking water quality goals. The goals are set to levels that produce no known are anticipated adverse health effects. The MCLGs include an adequate margin of safety.
6. Clean Water Act	Water Quality Criteria 40 C.F.R. Part 131 Water Quality Standards	Establishes non-enforceable standards to protect aquatic life. May be relevant and appropriate to surface water discharges, or may be a TBC.
7. Clean Water Act	Toxic Pollutant Effluent Standards 40 C.F.R. Part 129	Establishes effluent standards or prohibitions for certain toxic pollutants: aldrin/dieldrin, DDT, endrin, toxaphene, benzidine, and PCBs.
8. Clean Water Act	National Pollutant Discharge Elimination System (NPDES) 40 C.F.R. Parts 122, 125	Determines maximum concentrations for the discharge of pollutants from any point source into water of the United States.
9. Clean Water Act	National Pretreatment Standards 40 C.F.R. Part 403	Sets standards to control pollutants that pass through or interfere with treatment processes in publicly owned treatment works or that may contaminate sewage sludge.
10. Clean Air Act	National Primary and Secondary Ambient Air Quality Standards 40 C.F.R. Part 50	Establishes standards for ambient air quality to protect public health and welfare.

Table 2-1
Potential Federal Chemical-Specific ARARs (Cont.)

11. Human Health Risk Assessment Report (HHRA)	"Human Health Risk Assessment Report, Washington County Lead District, Washington County, Missouri" – prepared by Black & Veatch Special Projects, June 2009	Evaluates baseline health risk due to current site exposures and established contaminant levels in environmental media at the site for the protection of public health. The risk assessment approach using this data should be used in determining cleanup levels because ARARs are not available for contaminants in soils.
12. Superfund Lead-Contaminated Residential Sites Handbook	EPA OSWER 9285.7-50, August 2003.	Handbook developed by EPA to promote a nationally consistent decision making process for assessing and managing risks associated with lead contaminated residential sites across the country.

Table 2-2
Potential State Chemical-Specific ARARs

	Citation	Description
A. Potential ARARs		
1. Missouri Air Conservation Law	Missouri Department of Natural Resources RSMo 643 10 Code of State Regulation (CSR) 10	Sets ambient air quality standards for a variety of constituents, including particulate matter and lead. Provides long range goals for ambient air quality throughout Missouri in order to protect the public health and welfare.
2. Missouri Safe Drinking Water Act	Missouri Department of Natural Resources RSMo 640.100 – 140 10 CSR 60	Contains MCLs and monitoring requirements for drinking water supplies. Provides MCLs throughout Missouri in order to protect the public health and welfare.
3. Hazardous Waste Program	Missouri Department of Natural Resources Cleanup Levels for Missouri (CALM)	Outlines a process for determining cleanup goals at sites with known or suspected hazardous substance contamination.
4. Hazardous Waste Management Law	Missouri Department of Natural Resources Identification and Listing of Hazardous Waste 10 CSR 25-4.261	Defines those solid wastes which are subject to regulations as hazardous wasters under 10 CSR 25.
5. Missouri Clean Water Law	Missouri Department of Natural Resources RSMo 644.006 10 CSR 20-7.015	Sets forth the limits for various pollutants which are discharged to the various waters of the state. Set effluent standards that will protect receiving streams.
B. To Be Considered		
1. Missouri Clean Water Law	Missouri Department of Natural Resources Pending	Under this program, the State designates beneficial uses for waters of the state and to takes steps to determine if the uses are attainable and what the total maximum daily loads (TMDLs) should be to protect the designated uses. The TMDLs would be applicable to point discharges from abandoned mined lands, as well as active chat quarrying operations. The state TMDLs are currently not ARARs. However, Missouri and EPA are currently gathering supporting information for future implementation of a state TMDL program, and the TMDLs promulgated under this program could become ARARs when this program is formally implemented.
2. Missouri Department of Health	Missouri Department of Health Any Use Soil Levels Proposed	These proposed regulations recommend baseline levels for lead and cadmium in soil for residential or "any use" land use. However, the proposed clean up levels are extremely conservative compared to values used in the BHHRA and Risk Management Strategies documents.
3. Human Health Risk Assessment Report (HHRA)	"Human Health Risk Assessment Report, Washington County Lead District, Washington County, Missouri" – prepared by Black & Veatch Special Projects, June 2009	Evaluates baseline health risk due to current site exposures and established contaminant levels in environmental media at the site for the protection of public health. The risk assessment approach using this data should be used in determining cleanup levels because ARARs are not available for contaminants in soils.

Table 2-3
Potential Federal Location-Specific ARARs

	Citation	Description
A. Potential ARARs		
1. Historic project owned or controlled by a federal agency	National Historic Preservation Act: 16 U.S.C. 470, et.seq; 40 C.F.R. § 6.301; 36 C.F.R. Part 1.	Property within areas of the Site is included in or eligible for the National Register of Historic Places. The remedial alternatives will be designed to minimize the effect on historic landmarks.
2. Site within an area where action may cause irreparable harm, loss, or destruction of artifacts.	Archeological and Historic Preservation Act; 16 U.S.C. 469, 40 C.F.R. 6.301.	Property within areas of the site contains historical and archaeological data. The remedial alternative will be designed to minimize the effect on historical and archeological data.
3. Site located in area of critical habitat upon which endangered or threatened species depend.	Endangered Species Act of 1973, 16 U.S.C. 1531-1543; 50 C.F.R. Parts 17; 40 C.F.R. 6.302. Federal Migratory Bird Act; 16 U.S.C. 703-712.	Determination of the presence of endangered or threatened species. The remedial alternatives will be designed to conserve endangered or threatened species and their habitat, including consultation with the Department of Interior if such areas are affected.
4. Site located within a floodplain soil.	Protection of Floodplains, Executive Order 11988; 40 C.F.R. Part 6.302, Appendix A.	Remedial action will take place within a 100-year floodplain. The remedial action will be designed to avoid adversely impacting the floodplain in and around the soil repository to ensure that the action planning and budget reflects consideration of the flood hazards and floodplain management.
5. Wetlands located in and around the soil repository.	Protection of Wetlands; Executive Order 11990; 40 C.F.R. Part 6, Appendix A.	Remedial actions may affect wetlands. The remedial action will be designed to avoid adversely impacting wetlands wherever possible including minimizing wetlands destruction and preserving wetland values.
6. Structures in waterways in and around the soil repository.	Rivers & Harbors Act, 33 C.F.R. Parts 320-330.	Placement of structures in waterways is restricted to pre-approval of the U.S. Army Corps of Engineers.
7. Waters in and around the soil repository.	Clean Water Act, (Section 404 Permits) Dredge or Fill Substantive Requirements, 33 U.S.C. Parts 1251-1376; 40 C.F.R. Parts 230,231.	Capping, dike stabilization construction of berms and levees, and disposal of contaminated soil, waste material or dredged material are examples of activities that may involve a discharge of dredge or fill material. Four conditions must be satisfied before dredge and fill is an allowable alternative: 1. There must not be a practical alternative. 2. Discharge of dredged or fill material must not cause a violation of State water quality standards, violate applicable toxic effluent standards, jeopardize threatened or endangered species or injure a marine sanctuary. 3. No discharge shall be permitted that will cause or contribute to significant degradation of the water. 4. Appropriate steps to minimize adverse effects must be taken. Determine long- and short-term effects on physical, chemical, and biological components of the aquatic ecosystem.

Table 2-3 (Continued)
Potential Federal Location-Specific ARARs

	Citation	Description
8. Area containing fish and wildlife habitat in and around the removal repository.	Fish and Wildlife Conservation Act of 1980, 16 U.S.C. Part 2901 et seq.; 50 C.F.R. Part 83 and 16 U.S.C. Part 661, et seq. Federal Migratory Bird Act, 16 U.S.C. Part 703.	Regulates activity affecting wildlife and non-game fish. Remedial action will conserve and promote conservation of non-game fish and wildlife and their habitats.
9. Wild and Scenic River Act	16 U.S.C 1271 et seq.; Section 7, 40 C.F.R. 6.302(e)	Prohibits adverse effects on any of the scenic river listed in 16 U.S.C. 1276(a)
10. Fish and Wildlife Coordination Act	16 U.S.C Section 661 et seq.; 33 C.F.R Parts 320-330; 40 C.F.R 6.302	Requires consultation when a Federal department or agency proposes or authorizes any modification of any stream or other water body, and adequate provision for protection of fish and wildlife resources.
11. 100-year floodplain	Location Standard for Hazardous Waste Facilities- RCRA; 42 U.S.C. 6901; 40 C.F.R. 264.18(b).	RCRA hazardous waste treatment and disposal. Facility located in a 100-year floodplain must be designed, constructed, operated, and maintained to prevent washout during any 100-year/24 hour flood.
12. Historic Site, Buildings, and Antiquities Act	16 U.S.C. Section 461 et seq. 40 CFR Sect. 6.301(a)	Requires Federal agencies to consider the existence and location of landmarks on the National Registry of Natural Landmarks and to avoid undesirable impacts on such landmarks.
13. Salt Dome Formations, Salt Bed Formations, Underground Mines and Caves	40 C.F.R. 264.18	Placement of non-containerized or bulk liquid RCRA hazardous waste is prohibited within salt dome formations, underground mines, or caves.
B. To Be Considered		
1. Clean Water Act	Dredge or Fill Requirements (Section 404) 40 C.F.R. parts 230 and 231	Requires permits for discharge of dredged or fill material into navigable waters.
2. Wilderness Act	16 U.S.C 1311 et seq.; 50 C.F.R. 35.1 et seq.;	Requires that federally owned wilderness areas be administered to leave them unimpacted.
3. EPA Regulations on sole-source aquifers	40 C.F.R. 149	No activities, including drilling, in an ara designated a sole-source aquifer may take place without permission of the EPA.

Table 2-4
Potential State Location-Specific ARARs

	Citation	Description
A. Applicable Requirements		
1. Missouri Wildlife Code	Missouri Department of Natural Resources 3 CSR Sec. 10 – 4.111	Requires a determination of the presence or absence of endangered or threatened species, and provides for regulation of non-game wildlife. Places restrictions on actions affecting protected species. Remedial action will conserve and promote conservation of non-game fish and wildlife and their habitats.
B. To Be Considered	None	

Table 2-5
Potential Federal Action-Specific ARARs

	Citation	Description
A. Potential ARARs		
1. Disposal of Solid Waste in the Permanent Repository and closure of the Removal Repository.	Subtitle D of RCRA, Section 1008, Section 4001, et seq., 42 U.S.C. '6941, et seq.	State or Regional Solid Waste Plans and implementing federal and state regulations to control disposal of solid waste. The yard soils disposed in the repository may not exhibit the toxicity characteristic and, therefore, would not be a hazardous waste. However, these soils may be solid waste. Contaminated residential soils will be consolidated from yards throughout the site into a single location. The disposal of this waste material should be in accordance with regulated solid waste management practices.
2. Disposal of Hazardous Waste in the Permanent Repository and Designation as a Corrective Action Management Unit (CAMU).	Subtitle C of RCRA, Section 3001 et seq., 42 U.S.C. '6921, et seq. and implementing regulations at 40 C.F.R. Subpart S, Correction action for solid waste management units and temporary units, 40 C.F.R. '264.522	RCRA defines CAMUs to be used in connection with implementing remedial measures for corrective action under RCRA or at Superfund sites. Generally, a CAMU is used for consolidation or placement of remediation wastes within the contaminated areas at the facility. Placement of wastes in a CAMU does not constitute land disposal of hazardous waste and does not constitute creation of a unit subject to minimum technology requirements. The RCRA requirements of Subtitle C are not applicable to the disposal of residential yard soils in the repository. Residential yard soils contaminated from smelter fall out are not excluded from regulation under the RCRA exclusion for extraction, beneficiation and mineral processing. Therefore, yard soils exhibiting a RCRA toxicity characteristic would be regulated under Subtitle C of RCRA. However, because of the CAMU regulation, these residential soils are remediation wastes and may be disposed without triggering RCRA disposal requirements. The remedial action will comply with the requirements of the CAMU rule.
3. Solid Waste Disposal Act	Criteria for Classification of Solid Waste Disposal Facilities and Practices 40 C.F.R. Part 257	Establishes criteria for determining which solid waste disposal facilities and practices pose a reasonable probability of adverse effects on health, and thereby constitute prohibited open dumps.
4. Solid Waste Disposal Act	Hazardous Waste Management Systems General 40 C.F.R. Part 260 to 268	Establishes procedures and definitions pertaining to solid and hazardous waste.
5. Solid Waste Disposal Act	Identification and Listing of Hazardous Wastes 40 C.F.R. Part 261	Defines those solid wastes that are subject to regulations as hazardous wastes under 40 C.F.R. Parts 262-265 and Parts 124, 270, and 271.
6. Solid Waste Disposal Act	Standards Applicable to Generators of Hazardous Waste 40 C.F.R. Part 262 to 262.11	Waste Determination
7. Solid Waste Disposal Act	Standards Applicable to Transporters of Hazardous Waster 40 C.F.R. Part 263	Establishes standards that apply to persons transporting hazardous waste within the U.S. if the transportation requires a manifest under 40 C.F.R. Part 262.
8. Solid Waste Disposal Act	Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities 40 C.F.R. Part 264 and 265	Establishes minimum national standards which define the acceptable management of hazardous waste for owners and operators of facilities that treat, store, or dispose of hazardous waste.
9. Solid Waste Disposal Act	Land Disposal 40 C.F.R. Part 268	Establishes a ban or restrictions on burial of wastes and other hazardous materials.
10. Solid Waste Disposal Act	Hazardous Waste Permit Program 40 C.F.R. Par 270	Establishes provisions covering RCRA permitting requirements.

Table 2-5 (Continued)
Potential Federal Action-Specific ARARs

	Citation	Description
11. Clean Water Act	National Pollutant Discharge Elimination System (NPDES) 40 C.F.R. Parts 122-125	Requires permits for the discharge of pollutants from any point source into the waters of the United States.
12. Clean Water Act	Water Quality Criteria 40 C.F.R. Part 131 Water Quality Standards	Establishes non-enforceable standards to protect aquatic life.
13. Clean Air Act	National Ambient Air Quality Standards/ NESHAPS/ NSPS/ BACT/ PSD/ LAER 40 CFR 50.1-.17. .50-.54; .150-.154 .480-.489; 40 CFR 53.1-.33; 40 CFR 60; 40 CFR 61.01-.18 .50-.112, .240-.247	Treatment technology standards for emissions to air from: incinerators, surface impoundments, waste piles, landfills, and fugitive emissions.
14. Noise Control Act of 1972	42 U.S.C. Section 4901 et seq.	Federal activities must not result in noise that will jeopardize the health or welfare of the public
15. Hazardous Materials Transportation Act	Hazardous Materials Transportation Regulations 49 C.F.R. Parts 107, 171-177	Regulates transportation of hazardous materials.
16. NPDES Storm Water Discharge for Permanent Repository.	40 C.F.R. Part 122, ' 122.26	Establishes permitting process and discharge regulations for storm water. Required management of repository where waste materials come into contact with storm water. Also required during construction of the repository.
17. Transportation of excavated soils.	DOT Hazardous Material Transportation Regulations, 49 C.F.R. Parts 107, 171-177	Regulates transportation of hazardous wastes.
B. To Be Considered		
1. Safe Drinking Water Act	Standards for Owners and Operators of Public Water Supply Systems 40 C.F.R. 141	Provides treatment (water quality) requirements for public water supply.
2. Safe Drinking Water Act	Underground Injection Control (UIC) Regulations 40 C.F.R. Parts 144-147	Provides for protection of underground sources of drinking water.
3. Solid Waste Disposal Act	Underground Storage Tanks 40 C.F.R. Part 280	Establishes regulations related to underground storage tanks.
4. Clean Water Act	Toxic Pollutant Effluent Standards 40 C.F.R. Part 129	Establishes effluent standards or prohibitions for certain toxic pollutants: aldrin/dieldrin, DDT, endrin, toxaphene, benzidine, and PCBs.
5. Clean Water Act	National Pretreatment Standards 40 C.F.R. Part 403	Sets standards to control pollutants that pass through or interfere with treatment processes in publicly owned treatment works or that may contaminate sewage sludge.

Table 2-6
Potential State Action-Specific ARARs

	Citation	Description
A. Potential ARARs		
1. Missouri Board of Geological Registration Regulations	4 CSR 145-1.010	Any site-specific geological interpretations that affect human health and safety must be regulated.
2. Missouri Air Pollution Control Program	10 CSR 10-6.010 et seq.	Ambient concentrations of air pollutants should be less than their respective acceptable ambient levels at the site boundary.
3. Missouri Fugitive Particulate Matter Regulations	Missouri Department of Natural Resources 10 CSR 10-6.170	The Missouri fugitive particulate matter regulations contain restrictions on the release of particulate matter to ambient air. These regulations are applicable to any dust emissions that occur as a result of remedial actions taken at the site.
4. Missouri Clean Water Law – Effluent Regulations	Missouri Department of Natural Resources RSMo 644.006 – 564 10 CSR 20-7.015	Regulates the discharge of constituents from any point source, including storm water, into waters of the state. Provides for the maintenance and protection of public health and aquatic life uses of surface water and groundwater. The Missouri standards would be considered ARARs only if they are more stringent than the Federal standards. Regulates effluent discharges by limiting the amounts of various pollutants discharged to waters of the state. State permits would not be required under CERCLA, but the substantive provisions would be applicable.
5. Missouri Clean Water Law – Construction and Operating Permits	Missouri Department of Natural Resources 10 CSR 20-6.010	Requires permits for discharges from point sources of water contamination. Although permits are not required for remedial actions conducted under CERCLA, these regulations may be relevant and appropriate to corrective actions taken at the site. These regulations are applicable to any point source that occurs as a result of remedial actions taken at the site.
6. Missouri Clean Water Law – Storm Water Regulations	Missouri Department of Natural Resources 10 CSR 20-6.200	These regulations define Best Management Practices for land disturbances, including practices or procedures that would reduce the amount of metals in soils and sediments available for transport to waters of the state. Permits would not be required for actions taken under CERCLA, but the substantive provisions of these regulations would be applicable. The Missouri standards would be considered ARARs only if they are more stringent than the Federal standards. Requires permits for metal and non-metal mining facilities and land uses or disturbances that create point source discharges of storm water.
7. Missouri Clean Water Law – TMDL Regulations	MOU between EPA and MDNR regarding the state's implementation of Section 303(d) of the federal Clean Water Act and 10 CSR 20-7	The total maximum daily loads (TMDLs) would be applicable to point discharges from abandoned mined lands, as well as active chat quarrying operations. Requires the state to designate beneficial uses for waters of the state and to takes steps to determine if the uses are attainable and what the TMDLs should be to protect the designated uses.
8. Missouri Solid Waste Disposal Law	Missouri Department of Natural Resources RSMo 260.200 – 345 10 CSR 80	Regulates facilities used for the disposal nonhazardous industrial, commercial, agricultural, infections, and domestic wastes. Does not apply to the disposal of overburden, rock, tailings, matte, slag, or other waste material resulting from mining, milling, or smelting. However, the regulations are considered relevant and appropriate.

Table 2-6 (Continued)
Potential State Action-Specific ARARs

	Citation	Description
B. To Be Considered		
1. Missouri Hazardous Waste Management Law	Missouri Department of Natural Resources RSMo 260.350 – 434 10 CSR 25	Regulates the generation, identification, treatment and disposal of hazardous wastes. These regulations are not applicable, relevant or appropriate to mining and beneficiation wastes or to wastes generated from the reclamation of mined lands. However, certain substantive requirements related to design, operation and closure of disposal sites should be considered.
2. Missouri Metallic Minerals Waste Management Act	Missouri Department of Natural Resources RSMo 444.350 – 380 10CSR 45	Regulates disposal of waste from active metallic mineral mining, beneficiation, and processing. The regulations also contain technical guidelines, permitting, and closure requirements. Because these regulations contain closure standards for active metal mines, they are not ARARs but may be reviewed and considered during the design of removal actions.

3.0 Remedial Action Objectives and Action Levels

Residential property soil contamination from lead mining activities in Washington County was discussed in Section 1.0. The purpose of this section is to develop goals and action levels for the remedial action to be taken at OU1 of this Site. Section 4.0 identifies applicable technologies and process options to remediate residential property soil contamination. Sections 5.0 and 6.0 develop remedial action alternatives using the applicable technologies and evaluate the three alternatives using nine evaluation criteria. In Section 7.0, a comparative analysis of each alternative is completed.

3.1 Remedial Action Objectives

This section defines the goals of the remedial action, and identifies the remedial action objectives (RAOs) for residential soils at the Site. RAOs consist of quantitative goals for reducing human health and environmental risks and/or meeting established regulatory requirements at Superfund sites. RAOs are identified by reviewing site characterization data, BHHRA results, ARARs, and other relevant site information.

Based on current site data and evaluations of potential risk, lead was identified as being the primary contaminant of concern and the primary cause of human health risk from residential soils at the site is through direct ingestion and dermal contact.

The following RAOs have been developed for residential soils in Washington County:

- Reduce the risk of exposure of young children and pregnant females to lead such that an individual child, or group of similarly exposed children, have no greater than a 5 percent chance of having a blood-lead concentration exceeding 10 μg/dL.
- Reduce the risk of exposure of young children to concentrations of lead above 400 mg/kg in residential soils.
- Reduce the risk of exposure of young children to concentrations of arsenic above 22 mg/kg in residential soils.
- Reduce the risk of exposure of young children to concentrations of barium above 15,000 mg/kg in residential soils.
- Reduce the risk of exposure of young children to concentrations of cadmium above 70 mg/kg in residential soils.

3.2 Development of Action Levels

Lead was identified in the BHHRA as the primary COC in residential soils at the Site. A relative bioavailability value of 53.9 percent was determined from in-vitro testing using onsite residential soils (BVSPC 2010a). This value was used in the EPA's IEUBK Model to predict that young children (less than 7 years old) residing at the Site will have no greater than a 5 percent probability of having a blood-lead concentration of 10 μg/dL or greater at a surface soil concentration of 400 ppm or less. This 400 ppm Preliminary Remediation Goal (PRG) is based upon sieving the soil sample with a 60-mesh sieve and analysis of the sample by an XRF instrument. Residential properties with surface soil lead levels above 400 ppm will be considered for remediation during the EPA remedial action.

3.2.1 Number of Properties Requiring Remediation

The total number of residential properties that will be addressed under this FS is estimated at 98 properties. This number comes from properties with surface soil lead concentrations greater than 400 ppm. Two (2) of these properties are estimated to contain soil lead levels above 1,200 ppm.

4.0 Identification and Screening of Applicable Technologies and Process Options

General response actions have been identified to satisfy the RAO established for the Site. The general response actions include no-action, institutional controls, health education, excavation, and disposal. Remedial technologies and process options have been selected and screened for the general response actions. Remedial technologies would include excavation and off-site disposal. Process options for excavation and removal would involve partial or complete excavation of a property. The screening evaluation was based on technical and administrative implementability, effectiveness, and relative cost. The screening process of the remedial technologies and process options is discussed in this section.

4.1 No Action

The "no-action" general response action is required as a baseline alternative against which the effectiveness of the other alternatives can be compared. Under this alternative, no remedial actions are taken at the Site. Current risks posed from contaminants at the Site remain unmitigated, uncontrolled, and unmanaged. Actions taken to reduce the potential for exposure (e.g. institutional controls) are not to be included as a component of the no-action alternative.

4.2 Institutional Controls

Control measures that are social in nature can be as effective as remedial technologies in preventing human exposure to metals. Therefore, institutional controls (IC) are included in this section along with technologies. ICs are being developed to reduce or prevent exposure to contamination in soil and dust and to protect the remedy where wastes are left in place.

4.2.1 Government Controls

Implementation of future governmental controls, such as an ordinance requiring soil assessment sampling and permits for earthmoving activities, as well as restricting soil use in areas of known heavy metal contamination would be efficient and effective control measures. Discussion, collaboration, and evaluation with the state of Missouri, Washington County, and other local governments regarding these types of governmental controls will be initiated by EPA.

EPA will evaluate other types of ICs for residential properties and mine wastes at the Site and the final measures for governmental controls will be determined in the final FS, Proposed Plan, and ROD for the Site. Other ICs being considered include deed notices, local governmental controls such as building permit restrictions, restrictive covenants, and builder and developer certifications that require specific training on best management practices when developing potential properties impacted by historical mining practices.

4.2.2 *Access Restrictions*

Access restrictions can prevent physical contact with contaminated soils using physical barriers or signs. Physical access restrictions may include fencing, no trespassing signs, or security guards. These types of controls are not appropriate for residential properties because it is impractical to restrict resident's access to their own yards.

4.2.3 *Warning Barriers*

Warning barriers will be placed at the interface of lead-contaminated soil exceeding 1,200 ppm and the 12-inch or 24-inch layer of clean backfill soil to warn property owners of soil lead concentrations that may pose a health risk if disturbed.

4.3 Public Health Education

Public health education involves distribution of information about metal contamination exposure to people in areas affected by metals in soils. Education can alert residents to the issues of exposure routes, sources of metals contamination, people at risk, and preventative measures.

Educating citizens living in residences with metals in soils can be used as a supplemental action to reduce exposure and decrease risk. Education is appropriate because the primary exposure routes (ingestion and dermal exposure) are controllable. Specific education activities that may prove effective at reducing exposures include:

- Providing community education through meetings and literature.
- Providing appropriate intervention when children are identified as having elevated blood-lead levels.

Education, especially if it is the primary means of reaching remediation goals, must be an ongoing process. The main limitation to public education is that educational programs require not only the cooperation of public health institutions, but public cooperation as well, to be successful. In addition, public concern and awareness tend to wane with time unless a continual mechanism of public education is in place, in perpetuity. Additionally, education activities, conducted over a long period of time, can become expensive. Typically, the EPA prefers that health education is not a stand-alone remedy, but is used only in conjunction with an engineered action as a supplemental activity. For instance, the plastic warning barrier placed at the base of an excavated and backfilled area of a property is an engineered action that will only be fully effective when the property owner is educated on the purpose of the barrier and the precautions to be taken when performing future excavation activities at the property. Health education activities are useful to help address initial Site risks as the remedy is implemented, but will need to be continued into the future to inform the public about the soil lead contamination that remains on the Site.

4.4 Excavation

Excavation prevents human contact with soils through physical removal of soils for disposal. Residential soils can be either partially or totally removed. Soil excavation may be difficult and costly, particularly if properties are steeply sloped, or contain trees, shrubs, walkways, and driveways. The excavation process option includes backfilling excavated areas with clean soil or rock and establishing new vegetation in areas backfilled with soil. Some homeowners have lead-contaminated gravel driveways and parking areas that will be excavated and replaced with clean gravel material.

4.4.1 Partial Removal

Partial removal of soils refers to excavation of portions of properties containing concentrations of lead above the PRG and leaving behind soils with concentrations of lead below the action level. Portions of a property, but not the entire property, may contain soil with lead above the action level. Partial removal of soils may be appropriate for these properties. The limitation of partial excavation is the need for extensive testing to carefully delineate the soils to be removed. However, the cost for testing may be offset by the lower removal, transportation, and disposal costs for smaller quantities of soil. All excavated soils require appropriate disposal.

4.4.2 Complete Removal

Complete removal is the excavation of soil to a predetermined depth for an entire residential property. Complete excavation may not be appropriate because soils containing low concentrations of lead with little associated risk are removed, along with soils containing higher concentrations. Complete property soil removal may be most appropriate where the majority of the properties contain soil contamination above the action level, and eliminating the extensive sampling associated with partial removal reduces costs. The EPA has information for this Site indicating that many of the residential properties with soil concentrations above the PRG also have areas of their property below the PRG, meaning a complete removal may not be necessary. This technology is not considered further because of the much higher costs associated with complete removal.

4.5 Disposal

Disposal options must be considered with excavation. The lead-contaminated soils removed from residential areas will require disposal in a secure facility. Several options exist for disposal of lead-contaminated soil from the Site and are discussed in the following subsections.

4.5.1 Existing Repository

Soils could be disposed of in an existing repository. The advantage of using an existing repository are that there are no disposal fees as found at landfills, that the repository is partially designed and constructed, and that the soil will be used as cover material of existing mine tailings to reduce the potential for off-site migration via wind erosion and surface runoff. The EPA has used the Indian Creek Repository for storing contaminated residential soil during the previous time-critical removal actions conducted in Washington County. The EPA determined in the Remedial Action Plan (RAP) developed for the Indian Creek Facility that the 242-acre site will have more than enough capacity for excavated soils in Washington County (EPA 2006). The EPA will prepare a design for the Indian Creek Repository to ensure leaching of soil contaminants is controlled and the existing tailings pile is adequately capped.

A portion of the soils that have lead concentrations exceeding 1,200 ppm may fail the Toxicity Characteristic Leaching Procedure (TCLP) test and will need to be treated with a lead stabilization agent before final placement within the repository. Those soils that do not fail the TCLP test will be hauled to the Repository and capped without treatment.

4.5.2 Sanitary Landfill

Soils could also be disposed in off-site sanitary landfills as a special waste. The advantages of using existing landfills over the existing soil repository are the elimination of the need for a design and construction of a repository and the perpetual inspections and maintenance of a soil repository. The limitations of using an off-site disposal facility are possible regulatory constraints and cost. Costs for off-site disposal would be greater than at the Indian Creek Repository due to the extra transportation expense and fees at the landfill. Another disadvantage of disposing soil in an established sanitary landfill is the significant depletion of landfill capacity that would result. As with an off-site soil repository, excavated soils would require sampling and treating as necessary for the TCLP test for lead.

4.6 Screening of Identified Technologies

This section screens the remedial technologies identified in Sections 4.1 through 4.4 for further consideration in developing remedial alternatives to satisfy the RAO.

4.6.1 No-Action

The "no-action" general response action is required as a baseline alternative against which the effectiveness of the other alternatives can be compared. Under this alternative, no remedial actions are taken at the Site. Current risks posed from contaminants at the Site remain unmitigated, uncontrolled, and unmanaged. Actions taken to reduce the potential for exposure (e.g. site fencing, health education, etc.) are not to be included as a component of the no-action alternative.

4.6.2 *Institutional Controls*

Governmental Controls

Implementation of future governmental controls, such as an ordinance requiring soil assessment sampling and permits for earthmoving activities, as well as restricting soil use in areas of known heavy metal contamination would be efficient and effective control measures. Discussion, collaboration, and evaluation with the state of Missouri, Washington County, and other local governments regarding these types of governmental controls will be initiated by EPA. Other ICs being considered include deed notices, local governmental controls such as building permit restrictions, restrictive covenants, and builder and developer certifications that require specific training on best management practices when developing potential properties impacted by historical mining practices.

Access

Physical restrictions, such as fencing, do not have applicability to existing residential homes. Physical restrictions are not practical to limit access of young children to contaminated soil in residential properties. Access restrictions will not be retained in the development of remedial alternatives for the Site, and legal restrictions will be retained in the development of remedial alternatives.

Warning Barriers

Plastic warning barriers placed at the interface of lead-contaminated soil exceeding 1,200 ppm and a 12-inch or 24-inch layer of clean backfill soil are used to warn property owners of soil lead concentrations that may pose a health risk if disturbed. Placement of warning barriers will be retained in the development of remedial alternatives for the Site.

4.6.3 *Excavation*

Excavation of contaminated soil from residential properties is an accepted and highly utilized technology for addressing Site risks. Excavation is easily implementable with readily available equipment. For purposes of this report the excavation process option includes backfilling excavated properties with clean soil that meets the Missouri Risk-Based Corrective Action level. This technology will be carried forward for consideration in developing remedial alternatives to address the Site risks.

4.6.4 Disposal

Disposal of contaminated soil excavated from residential properties is an accepted and highly utilized technology for addressing Site risks. Disposal is easily implementable with readily available equipment. The Indian Creek Repository has been identified for disposal of the excavated contaminated soil. For purposes of this report the excavation process option includes transportation of the excavated soil to the Indian Creek Repository. This technology will be carried forward for consideration in developing remedial alternatives to address the Site risks.

4.6.5 Health Education

Health education is readily implementable and has been shown to reduce blood-lead concentrations in young children if efforts are aggressive and sustained. Health education will be retained for consideration in developing remedial alternatives to address Site risks.

5.0 Development of Alternatives

This section documents the development of remedial alternatives for residential property soils. Criteria are applied to limit the number of alternatives to only the most effective and implementable. The criteria for combining technologies into alternatives are as follows:

- Alternatives must address the RAO
- Alternatives must consist of unified groups of technologies
- Alternatives must represent the full range of possible remedies from No Action to Removal. Two remedial alternatives, along with the No Action alternative have been developed in this section to address residential properties.

The following general technologies identified in Section 4 have been retained for consideration in developing the remedial alternatives. Other technologies were eliminated as either not technically practical or cost effective for the Site.

- Institutional Controls
- Health Education
- Excavation
- Disposal

Appropriate soil treatment and disposal technologies have been combined into two alternatives to address human exposure to residential soils at the Site. A third alternative, No Action is also included as required by the NCP.

5.1 Preliminary Remedial Alternatives

The developed alternatives are based on the applicable technologies identified in Section 4 and were developed to most efficiently meet the RAO and satisfy the ARARs. Also included for comparison is the No Action Alternative.

5.1.1 Alternative 1: No Action

The EPA is required by the NCP, 40 C.F.R. § 300.430(e)(6), to evaluate the No Action Alternative. The No Action Alternative may be appropriate at some sites where a removal action has already occurred that sufficiently reduced risks to human health and the environment. However, at this Site, the concentrations of metals in many residential property soils remain at levels that present a risk to human health, (e.g., lead concentrations greater than 400 ppm) particularly for young children residing at the Site. The No Action Alternative is, therefore, not protective of human health.

5.1.2 *Alternative 2: 12-Inch Soil Excavation, Disposal, Vegetative Cover, Health Education, and Institutional Controls*

Under this alternative, approximately 98 residential properties contain or are expected to contain soil lead concentrations greater than 400 ppm and will be excavated to a depth of 12 inches and disposed. Contaminated soil would be removed to a maximum depth of 12 inches bgs and disposed. Excavated areas of properties would be backfilled with clean soil and seeded to reestablish lawns. Excavated soil would be disposed of at the existing mine waste repository at the Indian Creek Mine Tailings site. Vacuum cleaners would be provided to residences who have their yards remediated. Health education would be provided to citizens to make them aware of the dangers of lead exposure. The EPA would collaborate with State and local governments to implement institutional controls intended to restrict the movement of lead-contaminated soil and require soil sampling for lead prior to residential development. Following is a more in depth discussion of the actions to be taken under Alternative 2.

Excavation

Excavation of a property would be triggered when the highest recorded soil sample for the property contains greater than 400 ppm lead. Residential properties with at least one quadrant sample testing greater than 400 ppm for lead would have that quadrant and possibly drip zones remediated. The drip zones would be remediated if the lead concentration in the contaminated quadrant's drip zone is greater than 400 ppm.

Soil would be excavated using lightweight excavation equipment and hand tools in the portions of the property where the surface soil exceeds 400 ppm lead. Excavation would continue in depth until the underlying soils at the bottom of the excavation contain less than 400 ppm lead or to a maximum depth of 12 inches below ground surface. If soils having a lead concentration less than 1,200 ppm are not encountered at the 12-inch depth, EPA would place an obvious plastic marker barrier that is permeable, wide-meshed, and will not affect root growth, soil hydrology, or vegetation as a warning that digging lower will result in the exposure to soils at a contamination level that EPA has determined to be a human health concern. In existing garden areas at residential properties, the maximum excavation depth would be extended to 24 inches.

Excavation efforts are limited to one acre of area surrounding the residence, or 100 feet from the approximate center of the home. Excavation decisions are made using a field portable XRF unit with readings being made in-situ. When excavation goals are met, a five-point aliquot sample is collected in the quadrant. This sample is then homogenized, dried, and sieved with a 2 millimeter mesh sieve. XRF readings are then taken of the processed soil to confirm that remedial action objectives are achieved.

Clean fill and topsoil would be used to replace soil removed after excavation, returning the property to its original elevation and grade. EPA recommends that a minimum of 12 inches of clean soil be used to establish an adequate barrier from contaminated soil in a residential property for the protection of human health. The rational for establishing a minimum cover thickness of 12 inches is that the top 12 inches of soil in a residential property can be considered available for direct human contact (EPA 2003). Clean soils would have concentrations of the COCs below the following levels: Arsenic-19 mg/kg, Barium–7,500 mg/kg, Cadmium–16 mg/kg, and Lead–150 mg/kg.

Approximately 98 homes have or are expected to have lead concentrations in soils greater than 400 ppm. Based on EPA's previous soil removal activities around Richwoods, an average residential property may require removal of approximately 500 cubic yards of soil. A total of 49,000 cubic yards (98 residential properties x 500 cubic yards/property) of soil would require excavation, replacement, and disposal. Clean fill and topsoil would be used to replace soil removed after excavation, returning the property to its original elevation and grade.

Disposal

The Indian Creek Repository is currently owned by the Doe Run Company (Doe Run). EPA would be responsible for sampling remediation wastes to ensure that the soils meet the TCLP regulatory limit of 5 milligrams per liter (mg/L) lead in soil. Those soils which do not meet the 5 mg/L limit would be treated with a lead binding agent and then re-sampled for TCLP analysis. This procedure would be repeated until the soils pass TCLP testing so that the soil could be disposed as non-hazardous material.

Either Doe Run or EPA would be responsible for the placement of non-hazardous soils in the repository, final grading of the repository, and for placing a vegetative cover on the material. Doe Run would be responsible for operation & maintenance (O&M) of the repository following the placement of the cover soil and grass seed. O&M at the repository would include monitoring of surface water runoff, groundwater monitoring, and care of the vegetative cover. The EPA will review the O&M performance of the repository during each 5-year review of the Site, and will participate in the monitoring of storm water discharges until the completion of the soil cover on the tailings.

Vegetation Cover

After the soil has been replaced in excavated areas of residential yards, the property would be hydro-seeded to restore the lawn. Hydro-seeding is preferred over sodding for its ease of initial maintenance and significant cost reduction. However, sod may be used in areas of properties with steep slopes that would be subject to erosion before the hydro-seed could become established.

Health Education

Public health education would involve the circulation of information about exposure to metals in soils. This information may accompany the annual Washington County tax bill to ensure adequate distribution. Educating residents would be used as a supplemental action to reduce the potential for future exposures to metals contamination remaining at the Site. Exposure routes, sources of metals, people at risk, and preventative measures would be elements presented to the area residents in the mailing. Future development would also be addressed in the mailing to warn of the exposure hazards that exists from surface contamination, subsurface soil contamination exposed during excavation efforts, and backfilling with soils from an unknown source.

The annual information circular would also educate residents on the potential health effects of eating leafy or root vegetables grown in contaminated soils. Residents would be advised against raising vegetables in contaminated soils and excavating below the warning barrier. They would be advised to grow vegetables only in raised beds with uncontaminated soils, thoroughly wash any vegetables consumed, or grow only vegetables in which only the fruit is consumed, i.e., tomatoes, peppers, beans, etc.

Residences that undergo yard soil remediation would be provided with a new high-efficiency particulate air (HEPA) vacuum. Health education personnel would instruct the residents on the usage of the vacuums and also provide additional health education for the prevention of exposure to site contaminants.

Institutional Controls

The EPA would collaborate with the state, county and local governments to put in place ordinances that would require soil and gravel to be screened for lead prior to excavation or residential development.

Other ICs being considered would include deed notices, local governmental controls such as building permit restrictions, restrictive covenants, and builder and developer certifications that require specific training on best management practices when developing potential properties impacted by historical mining practices.

5.1.3 Alternative 3: 24-Inch Soil Excavation, Disposal, Vegetative Cover, Health Education, and Institutional Controls

Under this alternative, approximately 98 residential properties contain or are expected to contain soil lead concentrations greater than 400 ppm that will be excavated to a maximum depth of 24 inches and disposed. Excavated areas of properties would be backfilled with clean soil and seeded to re-establish lawns. Excavated soil would be disposed of at the existing mine waste repository at the Indian Creek Mine Tailings site. A vacuum cleaner would be provided to each resident that has their yard remediated. Health education would be provided to citizens. The EPA would collaborate with State and local governments to implement institutional controls intended to restrict the movement of lead-contaminated soil and require soil sampling for lead prior to residential development. Following is a more in depth discussion of the actions to be taken under Alternative 3.

Excavation

This alternative includes the excavation and removal of soil, and backfilling the excavation with clean soil. Excavation of a property would be triggered when the highest recorded soil sample for the property contains greater than 400 ppm lead. Residential properties with at least one quadrant sample testing greater than 400 ppm for lead would have that quadrant and possibly drip zones remediated. The drip zones would be remediated if the lead concentration in the contaminated quadrant's drip zone is greater than 400 ppm.

Soil would be excavated using lightweight excavation equipment and hand tools in the portions of the property where the surface soil exceeds 400 ppm lead. Excavation would continue in depth until the underlying soils at the bottom of the excavation contain less than 400 ppm lead or to a maximum depth of 24 inches below ground surface. No excavation will continue below 24 inches bgs. If at 24 inches bgs the soil lead concentration is equal to or greater than 1,200 mg/kg, EPA would place a marker barrier prior to backfilling with clean soil.

Excavation efforts are limited to one acre of area surrounding the residence, or 100 feet from the approximate center of the home. Excavation decisions are made using a field portable XRF unit with readings being made in-situ. When excavation goals are met, a five-point aliquot sample is collected in the quadrant. This sample is then homogenized, dried, and sieved with a 2 mm mesh sieve. XRF readings are then taken of the processed soil to confirm that remedial action objectives are achieved.

Clean fill and topsoil would be used to replace soil removed after excavation, returning the property to its original elevation and grade. Clean soils would have concentrations of the COCs below the following levels: Arsenic-19 mg/kg, Barium–7,500 mg/kg, Cadmium–16 mg/kg, and Lead–150 mg/kg.

Approximately 98 homes have or are expected to have lead concentrations in soils greater than 400 ppm. Based on EPA's previous soil removal activities around Richwoods involving excavation below 12 inches bgs, an average residential property may require removal of approximately 750 cubic yards. A total of 73,500 cubic yards (98 residential properties x 750 cubic yards/property) of soil would require excavation, replacement, and disposal. Clean fill and topsoil would be used to replace soil removed after excavation, returning the property to its original elevation and grade.

Disposal

The Indian Creek Repository is currently owned by the Doe Run Company (Doe Run). EPA would be responsible for sampling remediation wastes to ensure that the soils meet the TCLP regulatory limit of 5 milligrams per liter (mg/L) lead in soil. Those soils which do not meet the 5 mg/L limit would be treated with a lead binding agent and then resampled for TCLP analysis. This procedure would be repeated until the soils pass TCLP testing so that the soil could be disposed as non-hazardous material.

EPA and/or Doe Run would be responsible for the placement of non-hazardous soils in the repository, final grading of the repository, and for placing a vegetative cover on the material. Doe Run would be responsible for operation & maintenance (O&M) of the repository and waste. O&M at the repository would include monitoring of surface water runoff, groundwater monitoring, and care of the vegetative cover. The EPA will review the O&M practices during each 5-year review of the Site, and will participate in the monitoring of storm water discharges until the completion of the final soil cover of the tailings.

Vegetation Cover

After the topsoil has been placed, the property would be hydro-seeded to restore the lawn. Hydro-seeding is preferred over sodding for its ease of initial maintenance and significant cost reduction. However, sod may be used in areas of properties with steep slopes that would be subject to erosion before the hydro-seed could become established.

Health Education

Public health education would involve the circulation of information about exposure to metals in soils. This information may accompany the annual Washington County tax bill to ensure adequate distribution. Educating residents would be used as a supplemental action to reduce exposure and decrease risk. Exposure routes, sources of metals, people at risk, and preventative measures would be elements presented to the area residents in the mailing.

The annual circular would also include information on the potential health effects of eating leafy or root vegetables grown in contaminated soils. Residents would be advised against raising vegetables in lead-contaminated soils. They would be encouraged to grow vegetables only in raised beds with uncontaminated soils, thoroughly wash any vegetables consumed, or grow only vegetables in which only the fruit is consumed, i.e., tomatoes, peppers, beans, etc. Future development would also be addressed in the mailing to warn of the exposure hazards that exist from surface contamination, during excavation efforts, and backfilling with soils from an unknown source.

Residences which undergo yard soil remediation would be provided with a new high-efficiency particulate air (HEPA) vacuum. Health education personnel would instruct the residents on the usage of the vacuums and also provide additional health education for the prevention of exposure to site contaminants.

Institutional Controls

The EPA would consult ATSDR for concurrence on the need for institutional controls for soil lead contamination remaining at the 24-inch depth. The EPA anticipates that the need for institutional controls would be reduced under Alternative 3 because homeowners would dig in their yards to depths exceeding 24 inches on rare occasions, and believes that those instances would not result in soil lead levels remaining at the surface that would pose a significant exposure risk to lead. The frequency of post remediation excavation by residents to depths greater than 24 inches is expected to be minimal over time, and the perpetual implementation of institutional controls would be necessary on fewer properties in order for human health and the environment to be protected.

6.0 Detailed Evaluation of Remedial Alternatives

The NCP, 40 C.F.R. Section 300 et. seq., requires the EPA to evaluate selected remedial alternatives against nine criteria. A selected or preferred alternative should best satisfy all nine criteria before it can be implemented. The first step is to ensure that the remedial alternatives satisfy the threshold criteria. The two threshold criteria are overall protection of public health and the environment and compliance with the ARARs. In general, alternatives that do not satisfy these two criteria are rejected and not evaluated further. However, compliance with ARARs may be "waived" if site-specific circumstances warrant such a "waiver" as described in Section 300.430(f)(1)(ii)(C) of the NCP, 40 C.F.R. § 300.430(f)(1)(ii)(C).

The second step is to compare the remedial alternatives against a set of balancing criteria. The NCP establishes five balancing criteria, which include long-term effectiveness and permanence; reduction in toxicity, mobility, or volume achieved through treatment; implementability; short-term effectiveness; and cost. The third and final step is to evaluate the remedial alternatives on the basis of modifying criteria. The two modifying criteria are state and community acceptance. These final two criteria cannot be evaluated fully until the state and public have commented on the preferred alternative in the Proposed Plan and their comments have been analyzed.

6.1 Alternative Analysis Criteria

Each of the alternatives is subjected to nine evaluation criteria described in the NCP. The factors considered for each evaluation criterion and a brief description of each criterion are provided in the following subsections.

6.1.1 Threshold Criteria

Overall Protection of Human Health and the Environment

This criterion provides a final check to assess whether each alternative meets the requirement that it is protective of human health and the environment. The overall assessment of protection is based on a composite of factors assessed under the evaluation criteria, especially long-term effectiveness and permanence, short-term effectiveness, and compliance with ARARs.

Compliance With ARARs

This criterion is used to decide how each alternative meets federal, state, and local ARARs, as defined in CERCLA Section 121. Compliance is judged with respect to:

- chemical-specific ARARs,
- action-specific ARARs,

- location-specific ARARs,
- appropriate criteria, advisories and guidance (TBCs).

Potential chemical- and location-specific ARARs are identified in Tables 2-1 through 2-4. Potential federal and state action-specific ARARs relating to the remedial alternatives are identified in Tables 2-5 and 2-6.

6.1.2 Balancing Criteria

Long-Term Effectiveness

This criterion addresses the results of a remedial action in terms of the risk remaining at the Site after the remedial action objectives have been met. The primary focus of this evaluation is to determine the extent and effectiveness of the controls that may be required to manage the risk posed by treatment residuals and/or untreated wastes. The factors to be evaluated include:

- magnitude of risk remaining at the Site after the remedial objectives are met,
- adequacy of controls, and
- reliability of controls (i.e., assessment of potential failure of the technical components).

Short-Term Effectiveness

This criterion addresses the effects of the alternative during the construction and operation phase until the remedial actions have been completed and the selected level of protection has been achieved. Each alternative is evaluated with respect to:

- protection of community during remedial actions,
- protection of workers during remedial actions,
- time until remedial response objectives are achieved, and
- environmental impacts.

Reduction of Toxicity, Mobility, or Volume

This criterion addresses the statutory preference for selecting remedial actions that employ treatment technologies that permanently and significantly reduce toxicity, mobility, or volume of the contaminants. The factors to be evaluated include:

- treatment process and remedy,
- amount of hazardous material destroyed or treated,
- reduction in toxicity, mobility or volume of the contaminants,
- irreversibility of the treatment, and
- type and quantity of treatment residuals.

Implementability

This criterion addresses the technical and administrative feasibility of implementing an alternative and the availability of various services and materials required during its implementation. Technical feasibility considers:

- the ability to construct technology,
- reliability of technology,
- ease of undertaking additional remedial actions if necessary,
- monitoring considerations,
- coordination with other agencies (e.g., state and local) to obtain permits or approvals for implementing remedial actions,
- availability of treatment, storage capacity, and disposal services,
- availability of necessary equipment and specialists, and
- availability of prospective technologies.

Cost

This criterion addresses the capital costs, annual O&M costs, and present worth analysis. Capital costs consist of direct (construction) and indirect (non- construction and overhead) costs. Direct costs include expenditures for the equipment, labor and material necessary to perform remedial actions. Indirect costs include expenditures for engineering, financial, and other services that are not part of actual installation activities but are required to complete the installation of remedial alternatives. Annual O&M costs are post-construction costs necessary to ensure the continued effectiveness of a remedial action which include annual education mailings, distribution of HEPA vacuums along with instruction on proper cleaning, and soil repository monitoring and maintenance. A present worth analysis is used to evaluate expenditures that occur over different time periods by discounting all future costs to a common base year, usually the current year. This allows the costs of remedial action alternatives to be compared based on a single figure representing the amount of money that would be sufficient to cover all costs associated with the remedial action over its planned life. Discount rates were obtained from the Office of Management and Budget (OMB) circular No. A-94, Appendix C (OMB 2009).

6.1.3 Modifying Criteria

State Acceptance

This criterion evaluates the technical and administrative issues and concerns the state may have regarding each of the alternatives. The factors to be evaluated include those features of alternatives that the state supports, reservations of the state, and opposition of the state.

Community Acceptance

This criterion incorporates public concerns into the evaluation of the remedial alternatives. Typically, community acceptance cannot be determined during development of the FS. Complete evaluation of this criterion will be postponed until the Focused FS has been released for review by the public. Community acceptance will also be evaluated by comments on the Proposed Plan, where the alternatives will be summarized and a preferred alternative put forward to the public. This criterion will then be fully addressed in the interim ROD and the responsiveness summary.

6.2 Alternative Analysis

The following subsections present the individual analyses of the alternatives against the nine criteria.

6.2.1 Alternative 1: No Action

The no-action alternative would not involve any remedial actions, and the Site would remain in its present condition. Alternative 1, required by the NCP and CERCLA, is a baseline alternative against which the other alternatives can be compared.

Overall Protection of Human Health and the Environment

Because no remedial or monitoring activities would be conducted as part of Alternative 1, the RAO would not be met. This alternative does not provide protection for the environment or human health in Washington County because no actions are taken to mitigate the exposure to lead-contaminated soil.

Compliance With ARARs

This alternative does not meet the potential ARARs for the state or federal chemical-specific or location specific ARARs shown in Table 2-1 through 2-4. The chemical-specific ARARs include EPA revised interim soil-lead guidance for CERCLA sites and RCRA Corrective Action Facilities. The action-specific ARARs would not be met under this alternative (Table 2-5 and 2-6). Action-specific ARARs address proper disposal and transportation of lead contaminated soils.

Long-Term Effectiveness

The residual risk to human health and the environment associated with this alternative would be the same as the current risk. An evaluation of the adequacy and reliability of controls is not applicable to this alternative. The public would still be exposed to elevated levels of lead by direct contact with the contaminated soil in the yards and dust that is brought into the home.

Short-Term Effectiveness

Because no actions would be conducted, there would be no increase in the short-term risk to the workers, the community, or the environment. The public is still exposed to elevated levels of lead by direct contact with the property and dust that is brought into the home from the property.

Reduction of Toxicity, Mobility, or Volume

There is no reduction in the toxicity, mobility, or volume of contamination under the No Action alternative. Soil remediation would not be conducted; therefore, no mechanism would exist to evaluate any reductions in toxicity, mobility, and volume.

Implementability

The implementability criterion is not applicable because no remedial activities would occur. Services, materials, and activities normally needed to coordinate with other agencies would not be necessary. This alternative does not require implementation.

Cost

No capital or O&M costs would be associated with this alternative because no remedial actions would be conducted.

State Acceptance

It is assumed that this alternative would not be acceptable to the State.

Community Acceptance

The level of public awareness and involvement at the Site indicates that this alternative would not be acceptable to the community.

6.2.2 *Alternative 2: 12-Inch Soil Excavation, Disposal, Vegetative Cover, Health Education, and Institutional Controls*

Overall Protection of Human Health and the Environment

Exposure to contaminated soil is a significant health risk at the Site. Residential soils have been previously identified to be one of the primary contributors to risk associated with lead exposures. In order to reduce exposure to lead and the associated risks, the excavation alternative would replace lead-contaminated residential soils with clean soils, thereby breaking the exposure pathway between lead-contaminated soils and children.

Public health education would consist of the distribution of literature through annual mailings to all residents at the Site, and with the delivery of vacuum cleaners to residences that had yards remediated. Health education would alert residents to the issues of exposure routes, sources of lead, people at risk, purpose of warning barriers, and measures to control exposure to lead. Educating residents would be used as a supplemental action to reduce exposure and decrease risk. The circulation of health educational materials would be an ongoing process. Public concern and awareness fade with time unless continual periodic public educational programs are in place. Health education has been shown to reduce blood-lead concentrations in young children if efforts are aggressive and sustained.

Future development would be addressed in collaboration with state and local governments by implementing institutional controls such as ordinances requiring soil sampling prior to residential development or soil movement. Other institutional controls to be considered consist of deed notices, local governmental controls such as building permit restrictions, restrictive covenants, and builder and developer certifications that require specific training on best management practices when developing potential properties impacted by historical mining practices. The plastic warning barriers placed at the 12 -inch depth soil horizon where soil lead remains at or above 1,200 ppm serves to warn property owners where they may encounter soil lead at concentrations determined to pose a significant health risk.

Fugitive dust would need to be controlled and monitored concurrent with residential soils excavation and remediation to minimize soil recontamination. Control of fugitive dust during excavation would eliminate direct exposure to lead-contaminated dusts and reduce accumulation of lead dust in homes.

To further eliminate residents from lead in dust, HEPA vacuums would be provided to all residences with surface soil lead concentrations above 400 ppm that had their yards remediated. Distribution of the vacuums would also involve instruction on proper cleaning techniques. An estimated total of 117 (19 Time-Critical previously remediated properties + 98 estimated) vacuums would be provided under this alternative.

The soil disposal area, the Indian Creek Repository, is and would be further designed and engineered to protect human health and the environment, including groundwater and surface water. Groundwater and surface water would also be protected by treating those soils that fail TCLP with a lead stabilization agent before final placement in the repository. There would be no unacceptable impact associated with implementation of this alternative.

This alternative would control the significant exposure pathways associated with contaminated residential soils. Once residential soils excavation, soil replacement, revegetation is complete, the soils are properly disposed, an effective health education program is implemented, and residents are provided HEPA vacuums, risks associated with lead-contaminated residential soils would be mitigated. Ordinances controlling the spread of lead-contaminated soils exceeding health- based levels would further reduce the threat of exposure to lead. Therefore, Alternative No. 2 would be protective of human health and the environment.

Compliance With ARARs

Alternative 2 would comply with the chemical- and location-specific ARARs identified in Section 2 and detailed in Tables 2-1 through 2-4. As discussed previously, there are no promulgated laws or standards for lead-contaminated soil. However, a PRG of 400 ppm for lead in surface soils has been proposed for the protection of human health at this Site. This level was based on the guidance, criteria, and advisories identified as TBCs, such as the BHHRA, that are to be considered when evaluating remedial alternatives.

The potential federal and state action-specific ARARs for the excavation alternative are identified in Tables 2-5 and 2-6. The excavation alternative would comply with action-specific ARARs. The principal action-specific ARARs for this alternative would be the requirements for proper disposal of the excavated soils.

Long-Term Effectiveness

The residual risks (the risk remaining after implementation) would be significantly reduced under this alternative. Residential properties within the Site with surface soil lead concentrations at or above 400 ppm would have the contaminated soil removed to a depth of 12-inches or until the lead concentrations in the soil were below 400 ppm. If at 12 inches bgs the soil lead concentration is greater than 1,200 ppm, EPA would place an obvious plastic marker barrier that is permeable, wide-meshed, and will not affect root growth, soil hydrology, or vegetation as a warning that digging lower will result in the exposure to soils at a contamination level that EPA has determined to be a human health concern. The removal of contaminated soil, replacement with clean backfill, and revegetation ensures that the future potential for exposure to soil lead contamination would be significantly reduced.

The distribution of vacuum cleaners and health educational materials would further reduce the risk of exposure to residual soil lead contamination at the Site. Health education programs would educate residents about home gardening, interior house dust, proper hygiene, the plastic warning barriers, and other health concerns for young children and pregnant females residing within the Site.

Effectively implemented institutional controls such as ordinances, deed notices, and restrictive covenants would provide additional long-term protection from exposure to lead contamination remaining at the Site. Ordinances that would require building permit restrictions, soil sampling for lead prior to moving soil or residential development, and training for developers on the lead presence in surface soils are measures that can reduce exposures to lead-contaminated soils.

Short-Term Effectiveness

This alternative would be protective in the short term. Although lead-laden dust could potentially be generated during excavation, dust suppression would be implemented for the protection of residents and workers during the remedial action. The alternative would be lengthy to implement for all affected residences, requiring a year to complete. However, the length of time at any one residence during excavation would be short; therefore, the residential exposure to potential dust would be minimal.

The environmental impacts of this alternative would be minimal. A significant environmental aspect of this alternative would be the placement of the contaminated soils in the Indian Creek Repository. Provided storm water controls and other design and engineering controls for a stable repository are achieved and maintained, the repository would have no negative environmental impacts.

Reduction of Toxicity, Mobility, or Volume

Alternative 2 does not include treatment of the lead-contaminated residential surface soil, but would significantly reduce the mobility of the COCs by consolidation of the excavated contaminated soil at the Indian Creek tailings site. Although the exposure pathway via residential surface soil would be eliminated or minimized, the toxicity and volume of the material would not be reduced by these alternatives with the exception of the treated and stabilized soil which would otherwise fail the Toxicity Characteristic Leaching Procedure (TCLP) for lead. The toxicity of the stabilized soil would decrease, although the volume of this soil would minimally increase. The use of excavated yard soil as a vegetated cover for the mine tailings at Indian Creek is expected to reduce the mobility of the metals contamination associated with the mine tailings currently exposed at the ground surface. Proper design and long-term maintenance of the Indian Creek Repository are important components of Alternative 2 to ensure significant reduction of heavy metal mobility.

Implementability

This alternative would be fully implementable. Excavation methods, backfilling, and revegetation are typical engineering controls for lead contaminated soils. The experience of previous time-critical removal actions conducted by the EPA at this and other lead mining Superfund sites have shown that this action is readily implementable.

The health education and institutional control programs would be implementable. These activities would require cooperation and action by state or local governments.

Cost

The detailed cost summary of the total capital costs and present worth capital costs associated with the implementation of this alternative are presented in Table 6-1. There are 61 properties with lead contamination levels greater than 400 ppm currently identified at the Site, based upon previous sampling results. Residences which were not sampled due to lack of access have been included in the estimate for future remediation. Assumptions were made concerning the lead concentrations of unsampled soils based on the results of previous sampling in the area. Approximately 176 properties remain to be sampled at the Site. Based on previous sampling results it is assumed that 35 of these 176 properties will contain soil lead levels above 400 ppm (Twenty percent of 176 unsampled properties). 2 of the 176 properties are assumed to contain elevated levels of lead in soils above 1,200 ppm (One percent of 176 unsampled properties). The soils containing lead above 1,200 ppm would be stabilized prior to placement in a repository.

The excavation portion of this alternative is expected to have capital costs of $3 million, shown in Table 6-1, based on the estimated total of 49,000 cubic yards to be removed at 98 properties at $45 per cubic yard. The quantity of soil to be removed in future efforts for costing purposes was estimated to be an average of 500 cubic yards per residence.

Each residence which would incur a remedial action involving the removal of soils with lead concentrations above 400 ppm would be supplied a HEPA vacuum for interior dust removal. An estimated total of 117 vacuums would be provided. Educational instruction would be provided during vacuum delivery to help residents with proper cleaning and exposure reduction techniques.

Approximately 15 percent of the soils excavated with lead concentration above 1,200 ppm are estimated to fail TCLP and will need to be treated with a lead stabilization agent. The estimate will require 75 tons of lead stabilization agent.

Operation and Maintenance (O&M) for the soil repository is estimated to be $11,000 per year for as long as the repository remains in existence.

The total capital cost of Alternative 2 is estimated to be $2,948,000 and the total present worth cost is estimated to be $2,874,749. A discount rate presented in OMB Circular No. A-94, Appendix C, was used to calculate the present worth (OMB 2009).

State Acceptance

The state will be involved on every level in the determination of the preferred remedial alternative. State acceptance of this alternative will be based upon the information collected for this Focused FS and from the Proposed Plan.

Community Acceptance

Community acceptance will be fully determined after the public comment period closes for the Proposed Plan and this Focused FS.

6.2.3 Alternative 3: 24-Inch Soil Excavation, Disposal, Vegetative Cover, Health Education, and Institutional Controls

Overall Protection of Human Health and the Environment

Previous excavation and soil replacement efforts have proven to be a viable alternative. By excavating to the 24-inch depth, instances for property owner exposures are nearly eliminated. Future typical gardening and other soil disturbance activities would rarely have property owners digging below the 24-inch depth. Once residential soils excavation, replacement, disposal, and revegetation are completed and effective health education and institutional controls are implemented, risks associated with metal-contaminated residential soils would be mitigated. Therefore, Alternative No. 3 would be protective of human health and the environment.

As presented in Alternative 2, public health education would involve distribution of information in an annual mailing about lead exposure to people in areas affected by lead in soils. Health education would alert residents to the issues of exposure routes, sources of lead, people at risk, and measures to control exposure to lead. Educating residents would be used as a supplemental action to reduce exposure and decrease risk providing additional protection of health.

Future development would be addressed in collaboration with state and local governments by implementing institutional controls such as ordinances requiring soil sampling prior to residential development or soil movement. Other institutional controls to be considered consist of deed notices, local governmental controls such as building permit restrictions, restrictive covenants, and builder and developer certifications that require specific training on best management practices when developing potential properties impacted by historical mining practices. The plastic warning barriers placed at the 24-inch depth soil horizon where soil lead remains at or above 1,200 ppm serves to warn property owners where they may encounter soil lead at concentrations determined to pose a significant health risk.

Compliance With ARARs

Alternative 3 would comply with the chemical- and location-specific ARARs identified for the Site. As discussed previously, there are no promulgated laws or standards for lead-contaminated soil. However, a Preliminary Remediation Goal (PRG) of 400 ppm for lead in surface soils has been proposed for the protection of human health at this Site. This level was based on the guidance, criteria and advisories identified for consideration on other lead contaminated mining sites within the region.

Alternative 3 would comply with action-specific ARARs. The principal action-specific ARARs for this alternative would be the requirements for proper disposal of the excavated soils.

Long-Term Effectiveness

The residual risks (the risk remaining after implementation) would be significantly reduced under this alternative. Residential properties within the Site with surface soil (upper 24-inch horizon) concentrations at or above 400 ppm lead would have the contaminated soil removed and replaced with clean soil and vegetative cover. The excavation of contaminated soil, and revegetation, ensures that future potential for exposure would be significantly reduced.

The distribution of vacuum cleaners and health educational materials would further reduce the risk of exposure to residual soil lead contamination at the Site. Health education programs would educate residents about home gardening, interior house dust, proper hygiene, the plastic warning barriers, and other health concerns for young children and pregnant females residing within the Site. Effectively implemented institutional controls such as ordinances, deed notices, and restrictive covenants would provide additional long-term protection from exposure to lead contamination remaining at the Site. Ordinances that would require building permit restrictions, soil sampling for lead prior to moving soil or residential development, and training for developers on the lead presence in surface soils are measures that can reduce exposures to lead-contaminated soils. The EPA anticipates that the need for institutional controls would be reduced because homeowners would dig in their yards to depths exceeding 24 inches on rare occasions, and believes that those instances would not result in soil lead levels remaining at the surface that would pose a significant exposure risk to lead. The frequency of post remediation excavation by residents to depths greater than 24 inches is expected to be minimal over time, and the perpetual implementation of institutional controls would be necessary on fewer properties in order for human health and the environment to be protected.

Short-Term Effectiveness

This alternative would be protective in the short term. Although lead-laden dust could potentially be generated during clean soil placement, dust suppression would be implemented for the protection of community and workers during the remedial action. This potential dust exposure would occur over a longer time period than Alternative 2 due to the excavation of additional soil. This alternative would be lengthy to implement for all affected residences, requiring years to complete. However, the length of time at any one residence during excavation activities would be short; therefore, the residential exposure to dust would be minimal.

The environmental impacts of this alternative would be minimal. A significant environmental aspect of this alternative would be the placement of the contaminated soils in the Indian Creek Repository. Provided storm water controls and other design and engineering controls for a stable repository are achieved and maintained, the repository would have no negative environmental impacts.

Reduction of Toxicity, Mobility, or Volume

Alternative 3 does not include treatment of the lead-contaminated residential surface soil, but would significantly reduce the mobility of the COCs by consolidation of the excavated contaminated soil at the Indian Creek tailings site. Although the exposure pathway via residential surface soil would be eliminated or minimized, the toxicity and volume of the material would not be reduced by these alternatives with the exception of the treated and stabilized soil which would otherwise fail the Toxicity Characteristic Leaching Procedure (TCLP) for lead. The toxicity of the stabilized soil would decrease, although the volume of this soil would minimally increase. The use of excavated yard soil as a vegetated cover for the mine tailings at Indian Creek is expected to reduce the mobility of the metals contamination associated with the mine tailings. Proper long-term maintenance of the Indian Creek Repository is an important component of Alternative 3 to ensure significant reduction of heavy metal mobility.

Implementability

This alternative would be fully implementable. Excavation methods, backfilling, and revegetation are typical engineering controls for lead contaminated soils. The experience of previous Site time-critical removal actions conducted by the EPA at this and other lead mining Superfund sites have shown that this action is readily implementable.

The distribution of vacuums, health education and institutional control programs would be implementable. Health education and the implementation of institutional controls would require cooperation and action by state or local governments.

Cost

The detailed cost summary of the total capital costs and present worth capital costs associated with the implementation of this alternative is presented in Table 6-2. There are 98 properties with lead contamination levels greater than 400 ppm currently at the Site, based upon previous sampling results. Residences which were not sampled due to lack of access have been included in the estimate for future remediation. Assumptions were made concerning the lead concentrations of unsampled soils based on the results of previous sampling in the area. Approximately 176 properties remain to be sampled at the Site. Based on previous sampling results it is assumed that 35 of these 176 properties will contain soil lead levels above 400 ppm (Twenty percent of 176 unsampled properties). 2 of the 176 properties are assumed to contain elevated levels of lead in soils above 1,200 ppm (One percent of 176 unsampled properties). The soils containing lead above 1,200 ppm would be stabilized prior to placement in a repository.

The excavation portion of this alternative is expected to have capital costs of $4 million, shown in Table 6-2, based on the estimated total of 73,500 cubic yards to be removed at 98 properties at $45 per cubic yard. The quantity of soil to be removed in future efforts for costing purposes was estimated to be an average of 750 cubic yards per residence.

Each residence which would incur a remedial action involving the removal of surface soils with lead concentrations above 400 ppm would be supplied a HEPA vacuum for interior dust removal. An estimated total of 117 vacuums would be provided. Educational instruction would be provided during vacuum delivery to help residents with proper cleaning and exposure reduction techniques.

Approximately 15 percent of the soils excavated with lead concentration above 1,200 ppm are estimated to fail TCLP and will need to be treated with a lead stabilization agent. The estimate will require 114 tons of lead stabilization agents.

Operation and Maintenance (O&M) for the soil repository is estimated to be $11,000 per year for as long as the repository remains in existence.

The total capital cost of Alternative 3 is estimated to be $ 4,223,000 and the total present worth cost is estimated to be $4,095,050. A discount rate presented in OMB Circular No. A-94, Appendix C, was used to calculate the present worth (OMB 2009).

State Acceptance

The state will be involved on every level in the determination of the preferred remedial alternative. State acceptance of this alternative will be based upon the information collected for this Focused FS and from the Proposed Plan.

Community Acceptance

Community acceptance will be fully determined after the public comment period closes for the Final FS and the Proposed Plan.

Table 6-1
Present Worth Cost Estimate
Alternative 2- 12-Inch Soil Excavation, Disposal, Vegetative Cover, and Health Education

Cost Estimate Component	Quantity	Units	Unit Cost	Capital Costs
Capital Costs				
Mobilization	1		$50,000	$50,000
Property Access, Contaminant Assessment	98	Properties	$400	$39,200
Sampling Activities	176	Properties	$600	$105,600
Soil Movement (excavation, transport, backfilll, dust suppression)	49,000	yd^3	$45	$2,205,000
Post Cleanup Reports	98	Properties	$100	$9,800
Vegetative Cover	98	Properties	$855	$83,790
Lead Stabilization	75	Tons SulfiTech	$250	$18,750
Air Monitoring	3	years	$2,800	$8,400
Soil Movement and Grading at Landfill	49,000	yd^3	$1.5	$73,500
Vegetative Cover at Landfill	80	acre	$1,500	$120,000
DIRECT CAPITAL COST SUBTOTAL				$2,714,040
Bid Contingency (5%)				$135,700
Scope Contingency (2%)				$54,300
TOTAL DIRECT CAPITAL COST				$2,904,040
Pemitting and Legal (1%)				$29,000
CONSTRUCTION COST TOTAL				$2,933,040
Engineering Design (.05%)				$14,700
NON-RECURRING CAPITAL COST				$2,948,000

OTHER ANNUAL COSTS			Annual	Total Cost
HEPA vacuums (117 properties @$100 each)	3	year	$3,900	$11,700
Vacuum Distribution/Health Education	3	year	$2,925	$8,775
Institutional Controls (Annual Mailings = 474 total households)	3	year	$711	$2,133
Allowance for Repository Maintenance Cost	3	year	$11,000	$33,000

Discounted Cost for Project Year

Year	Annual Costs	Costs Include:
1	$1,001,203	
2	$949,251	
3	$924,295	
Total Present Worth of Costs	**$2,874,749**	

* Discount factors calculated from nominal interest rates given in OMB circular no. A-94.

Table 6-2
Present Worth Cost Estimate
Alternative 3 - 24-Inch Soil Excavation, Disposal, Vegetative Cover, and Health Education

Cost Estimate Component	Quantity	Units	Unit Cost	Capital Costs
Capital Costs				
Mobilization	1		$50,000	$50,000
Property Access, Contaminant Assessment	98	Properties	$400	$39,200
Sample Property	176	Properties	$600	$105,600
Soil Movement (excavation, transport, backfilll, dust suppression)	73,500	yd^3	$45	$3,307,500
Post Cleanup Reports	98	Properties	$100	$9,800
Vegetative Cover	98	Properties	$855	$83,790
Lead Stabilization	114	Tons SulfiTech	$250	$28,500
Air Monitoring	5	years	$2,800	$14,000
Deed Notices	98	Properties	$200	$19,600
Soil Movement and Grading at Landfill	73,500	yd^3	$1.5	$110,250
Vegetative Cover at Landfill	80	acre	$1,500	$120,000
DIRECT CAPITAL COST SUBTOTAL				$3,888,240
Bid Contingnency (5%)				$194,400
Scope Contingency (2%)				$77,800
TOTAL DIRECT CAPITAL COST				$4,160,440
Pemitting and Legal (1%)				$41,600
CONSTRUCTION COST TOTAL				$4,202,040
Engineering Design (.05%)				$21,000
NON-RECURRING CAPITAL COST				$4,223,000

OTHER ANNUAL COSTS			Annual	Total
HEPA vacuums (117 properties @$100 each)	3	year	$3,900	$11,700
Vacuum Distribution/Health Education	3	year	$2,925	$8,775
Institutional Controls (Annual Mailings = 474 total households)	3	year	$711	$2,133
Allowance for Repository Maintenance Cost	3	year	$11,000	$33,000

Discounted Cost for Project Year

Year	Annual Costs	Costs Include:
1	$1,426,203	
2	$1,352,198	
3	$1,316,649	
Total Present Worth of Costs	**$4,095,050**	

* Discount factors calculated from nominal interest rates given in OMB circular no. A-94.

7.0 Comparative Analysis of Alternatives

A comparative analysis of alternatives using each of the nine evaluation criteria, as required by federal regulation, is presented in this section. The purpose of this analysis is to identify the advantages and disadvantages of each alternative relative to the other alternatives. A separate comparison of the alternatives is presented under the heading of each criterion.

7.1 Protection of Human Health and the Environment

Protection of human health and the environment is addressed to varying degrees by the three evaluated alternatives. The No Action Alternative would have no effect on the Site. Therefore, it does not address any of the identified risks for human health.

As part of Alternatives 2 and 3, excavation provides protection of human health through reducing exposure to metals in contaminated soils at residential properties. Protection is provided by removing, or capping, the contaminated soil from the exposure pathway and installation of clean soil. For both alternatives, health education programs provide ongoing risk reduction. Alternatives 2 and 3 provide institutional controls of marker barriers at residential properties where lead contamination exceeding 400 ppm is left at depth, 12 inches for Alternative 2 and 24 inches for Alternative 3. Alternative 2 would remove the significant exposure pathway associated with contaminated residential property soils. Once excavation, soil replacement, and revegetation are complete, the soils are properly disposed, institutional controls and a health education program are implemented, risks associated with lead-contaminated residential property soil will be mitigated. Therefore, Alternative 2 is protective of human health and the environment. Alternative 3 would also be protective of human health and the environment. However, enforceable institutional controls may be necessary at fewer properties due to the lesser likelihood of post remediation excavation by homeowners to depths greater than 24 inches.

7.2 Compliance with ARARs

The No Action Alternative would not meet ARARs, whereas Alternatives 2 and 3 meet federal and state ARARs. Chemical-, location-, and action-specific state and federal ARARs for Alternatives 2 and 3 would be achieved by making sure all soil is excavated, capped, transported, and disposed of properly. Alternatives 2 and 3 will achieve ambient air quality regulations by keeping the duration of excavation at each residence to a minimum and by suppressing dust while excavating and transporting contaminated soil. Alternatives 2 and 3 would remove or cover all soil greater than 400 ppm and would achieve the goal of reducing the risk of exposure of young children to lead such that an individual child, or group of similarly exposed children, have no greater than a 5 percent chance of having a blood-lead concentration exceeding 10 µg/dL.

Water quality criteria for Alternatives 2 and 3 would be met during excavation by using *Best Management Practices* to minimize storm run-off and then hydro-seeding or sodding the property when the soil is replaced. Soils failing TCLP would be treated with a lead stabilization agent before final placement in the repository and all excavated soils stored in the repository would be capped with clean soil. *Best Management Practices* would be implemented to prevent storm run-off (i.e., berms, silt-fences, etc.).

7.3 Long-Term Effectiveness and Permanence

Alternative 1 would not provide any long-term effectiveness for the protection of human health and the environment. Under Alternatives 2 and 3 the residual risks (the risk remaining after implementation) would be significantly reduced. Residential properties within the site with soil concentrations at or above 400 ppm lead in Alternative 2 would have the contaminated soil removed or covered to a maximum depth of 12 inches or a depth that meets the site cleanup levels. The placement of a permeable marker barrier at the 12-inch depth would alert property owners of the presence of lead-contaminated soils at or above 1,200 ppm lead at depth. Alternative 3 would provide more permanence by removing lead-contaminated soils to a maximum depth of 24 inches which would ensure that only in rare instances of deep excavation could there be exposures to lead-contaminated soils. The removal of contaminated soil, replacement with clean backfill and re-vegetation, ensures that future potential for exposure would be significantly reduced in Alternatives 2 & 3.

A significant aspect of Alternatives 2 and 3 is the placement of the contaminated soils in the Indian Creek Repository. The repository would require storm water controls and other design and engineering controls to provide a long-term stable repository.

Health educational mailings provided on an annual basis would provide long term effectiveness for Alternatives 2 and 3 by refreshing property owners on the hazards present at the Site. Proper cleaning techniques and additional education would be provided when HEPA vacuums are delivered to residences that had their soils remediated. General awareness will increase with time as residents become more prudent with handling contaminated soils in the region.

Effectively implemented institutional controls included as part of Alternatives 2 and 3 would provide long-term effectiveness and permanence as long as they are implemented. It is anticipated that for Alternative 3, institutional controls would be necessary at fewer properties as compared to Alternative 2 due to the lesser likelihood of post remediation excavations by homeowners to depths greater than 24 inches.

7.4 Short-Term Effectiveness

There would be no short-term risk to workers for Alternative 1 because no remediation efforts would be performed. However, exposure pathways for the public and environment would remain.

Alternative 2 would have increased short-term risks for the public, environment, and construction workers from excavation and transportation efforts. Disturbed contaminated soil could enter the ambient air during excavation and transportation. However, dust suppression would be implemented for the protection of community and workers during the remedial action. The alternative would be lengthy to implement for all affected residences, requiring years to complete. However, the length of time at any one residence during excavation would be minimal; therefore, the residential exposure to potential dust would be minimal.

Alternative 3 has the same airborne dust risks as Alternative 2 yet at an increased level because of the larger amount of contaminated soils that would be excavated and hauled.

7.5 Reduction of Toxicity, Mobility or Volume

There would be no reduction in the toxicity, mobility, or volume of contamination under the No Action Alternative (Alternative 1). Alternatives 2 & 3 would significantly reduce the mobility of the contaminants of concern by consolidation of the contaminated soils at the Indian Creek Repository. Soils that fail TCLP testing would be treated with a lead stabilization agent before disposal in the repository. The exposure pathway would be eliminated or minimized, and the toxicity of the material would be reduced. Proper long-term maintenance of the Indian Creek Repository is an important component of Alternatives 2 & 3 that ensures the significant reduction of mobility.

Relative to Alternative 2, Alternative 3 would provide a greater reduction in volume of the contaminated soils remaining at residential properties, thereby reducing the toxicity of the contamination. By providing residents with HEPA vacuums, Alternatives 2 and 3 would reduce the volume of lead dust and mobility into the homes.

7.6 Implementability

Alternative 1 would not require any implementation. Alternatives 2 and 3 would be readily implementable because equipment and trained construction personnel are readily available. The technologies in these alternatives are also technically feasible from an engineering perspective. Excavation methods, backfilling, and revegetation are typical engineering controls. The experience of previous Site time-critical removal actions conducted by the EPA at this and other lead mining Superfund sites have shown that the replacement of lead-contaminated surface soil prescribed for Alternatives 2 and 3 would be readily implementable. The provision of vacuums and health education to residences at lead remediation sites is also readily implementable. The effective implementation of institutional controls prescribed for Alternatives 2 and 3 will require collaboration and cooperation from state and local governments, but can be achieved.

7.7 Cost

The total present worth of Alternative 1 is estimated to be $0. The total present worth of Alternative 2 is estimated to be $2,874,749. The total present worth of Alternative 3 is estimated to be $4,095,050.

No capital or O&M costs would be associated with Alternative 1 because no remedial actions would be conducted. Alternatives 2 & 3 incur costs for the informational mailings provided to residents as well as for the O&M involved with Indian Creek Repository. Engineering fees are also allocated for the design of the capping of the Repository.

7.8 State Acceptance

The state will be involved on every level in the determination of the preferred remedial alternative. State acceptance of this alternative will be based upon the information collected for this Focused FS and from the Proposed Plan.

7.9 Community Acceptance

Community acceptance of the alternatives will be fully determined after the public comment period closes for the Proposed Plan and this Focused FS.

8.0 References

EPA 2008, *Ecological Risk Assessment,* Washington County Lead District – Potosi Site, prepared by USEPA Region 7; December 2008.

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EPA 2006, *Statement of Basis for Remedial Action Plan, Indian Creek Facility,* Washington County, Missouri, prepared by USEPA Region 7; September 28, 2006.

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